# ORB EAST END CROSSING
# CABLE-STAYED BRIDGE CONSTRUCTION

*Ben Soule, International Bridge Technologies, Inc.*
*Doug VanSlambrook, Walsh Construction*
*Shawn Woodruff, Parsons Corporation*

# PROJECT OVERVIEW

THE OHIO RIVER BRIDGES

# PUBLIC-PRIVATE PARTNERSHIP

THE OHIO RIVER BRIDGES

- Design, build, finance, operate, maintain
- 35 year term
- Availability payments

# SECTION 5 TEAM ORGANIZATION

THE OHIO RIVER BRIDGES

Indiana Finance Authority

INDIANA DEPARTMENT OF TRANSPORTATION — INDOT

PARSONS

**Owner/Owner's Rep.**

JACOBS™

INTERNATIONAL BRIDGE TECHNOLOGIES, INC.

**Permanent Structure / Construction Engineering**

WVB East End Partners

**Developer**

CONSTRUCTION

**Design-Builder**

JSE

VINCI CONSTRUCTION FRANCE

**Temporary Works**

# ENGINEERS OF RECORD

THE OHIO RIVER BRIDGES

JACOBS™

INTERNATIONAL BRIDGE TECHNOLOGIES, INC.

# CONTRACTOR

THE OHIO RIVER BRIDGES

WV CONSTRUCTION

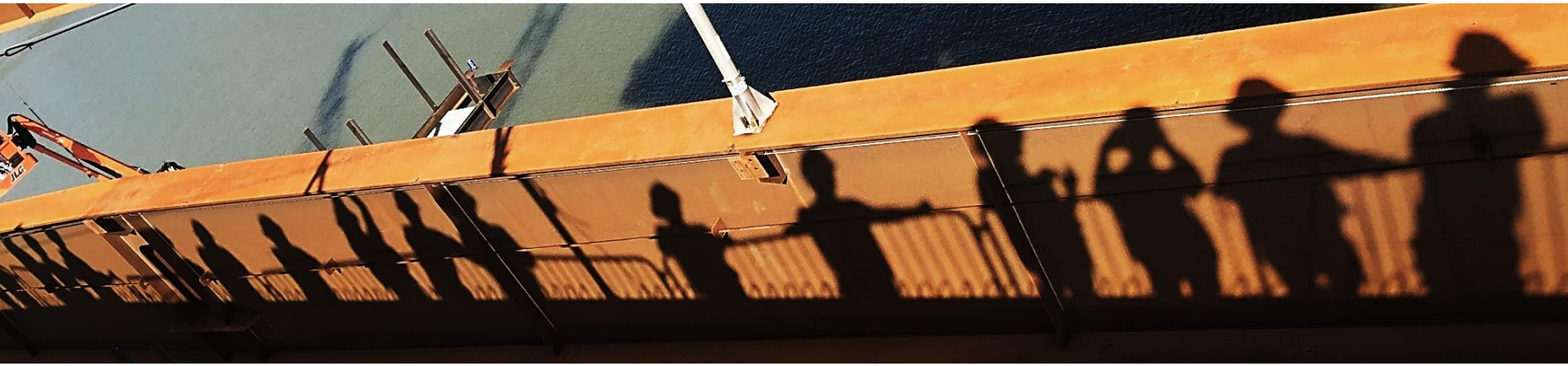
**Construction Joint Venture**

WALSH

VINCI CONSTRUCTION | GRANDS PROJETS

# ADDITIONAL TEAM MEMBERS

THE OHIO RIVER BRIDGES



Stantec

WJE

ruby+associates
STRUCTURAL ENGINEERS

CTL GROUP

BUCKLAND & TAYLOR LTD.

COWI

Circle City Rebar, LLC
"Reinforcing The Future"

U.S. Department of Transportation
Federal Highway Administration

KENTUCKY TRANSPORTATION CABINET

HIGH

FREYSSINET

BADD
Fabrication ~ Water Jet Cutting ~ Engineering ~ Machining

CARR Concrete
a division of CXT, Inc.

J.R. HOE AND SONS

ADVANCE
READY MIX CONCRETE, INC.

BLN
BEAM·LONGEST·NEFF

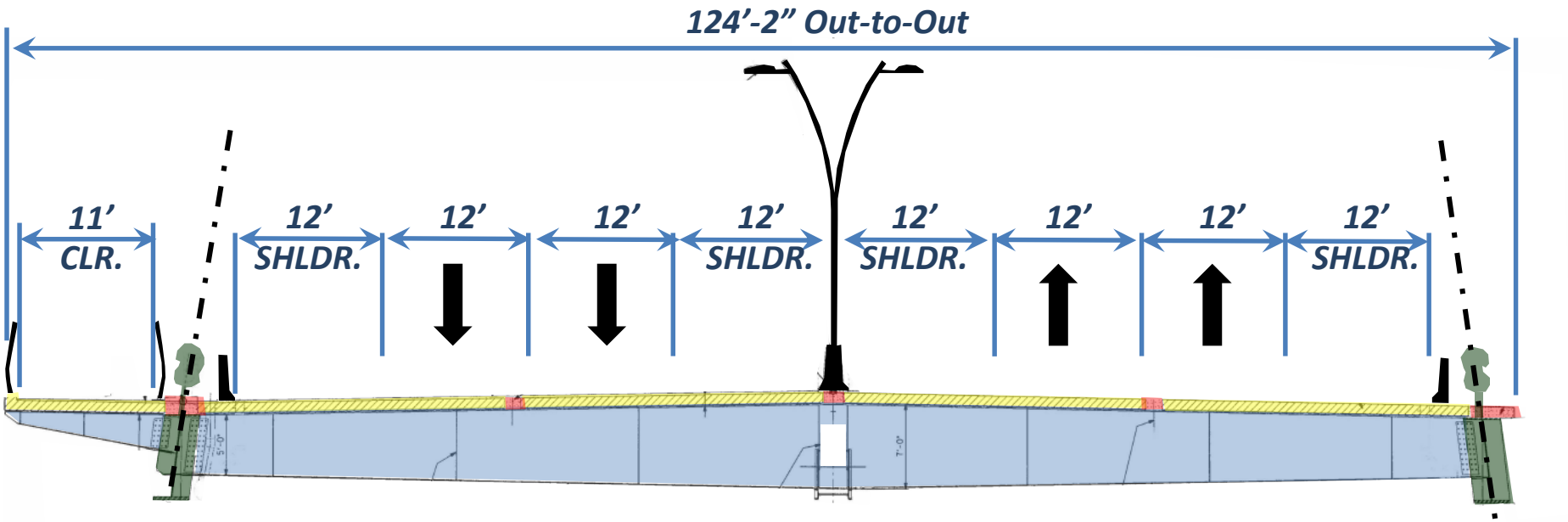
NORTHPOINTE ENGINEERING & SURVEYING, Inc.

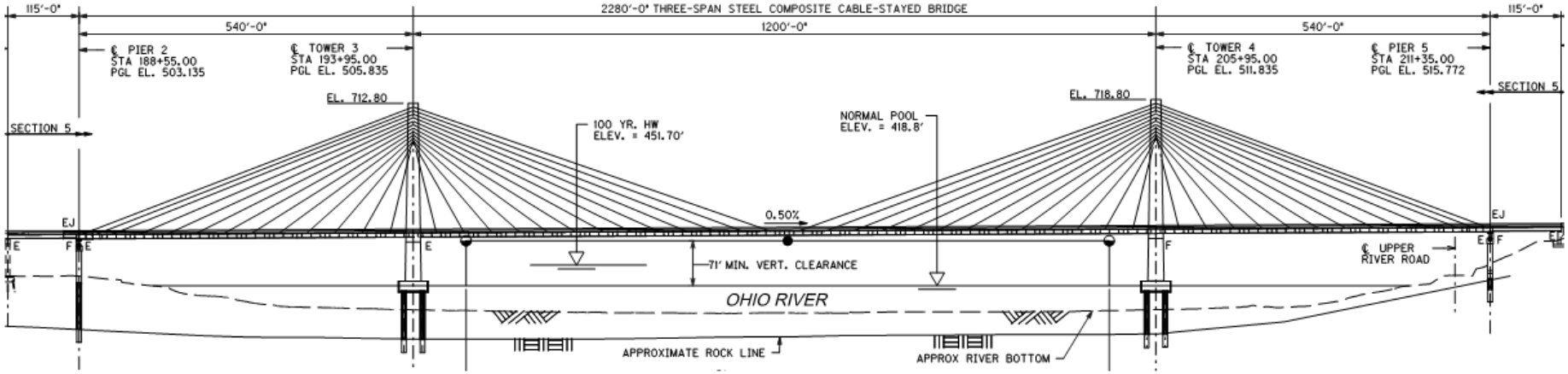
VS ENGINEERING

# BRIDGE OVERVIEW

THE OHIO RIVER BRIDGES

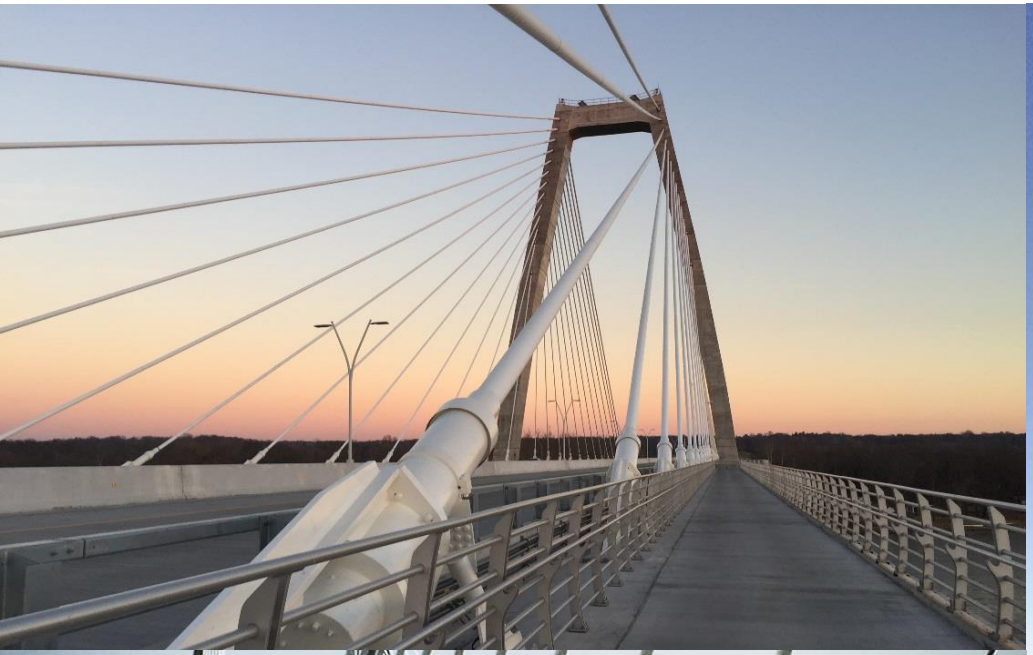
# SUPERSTRUCTURE



# SUPERSTRUCTURE

# SHARED USE PATH - DAY



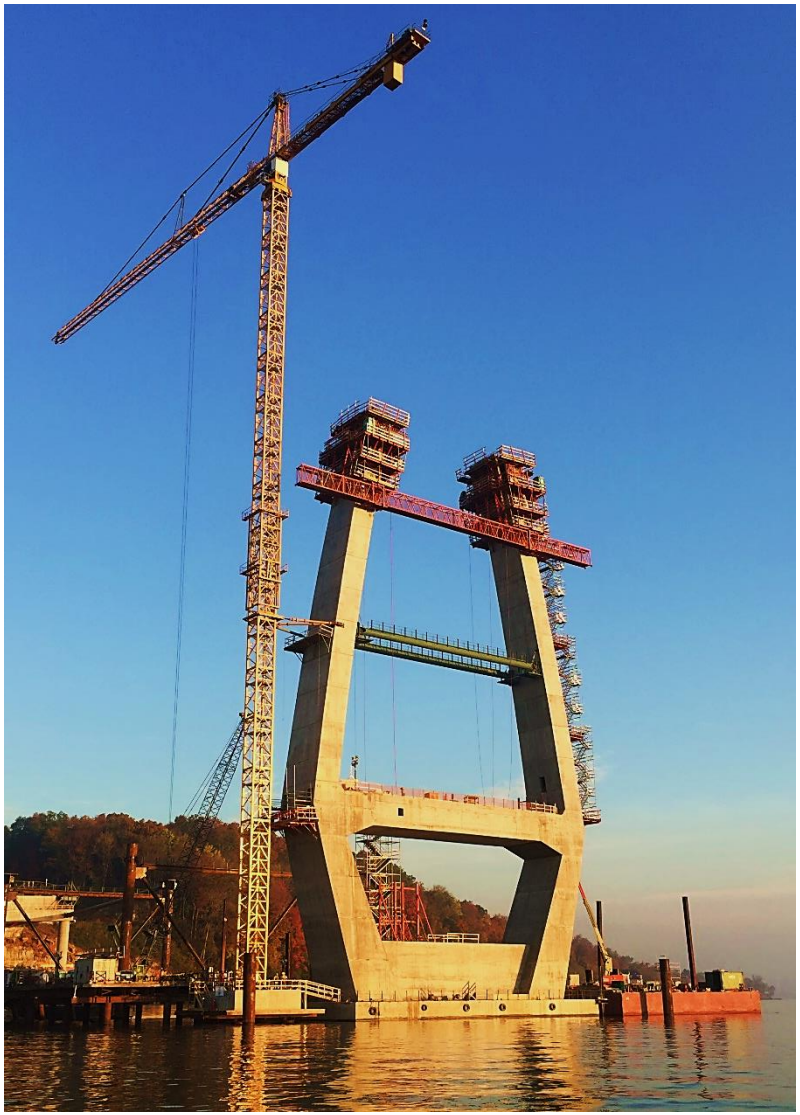
# SHARED USE PATH - NIGHT

THE OHIO RIVER BRIDGES

# SUBSTRUCTURE

THE OHIO RIVER BRIDGES

# SERVICE LIFE DESIGN



- Performance-based approach based on location/exposure
  - Concrete mix designs
  - Reinforcing type and cover for permanent/temporary elements
- Product selection
- Repairs
- Dissimilar metals
- Re-detailing of elements
- Developer involvement

# SCHEDULE

- Bridge Construction of Permanent Works Started: August 2013
- Bridge Opening: December 2016

| Construction Activity | Duration |
|---|---|
| Tower Foundations (average) | 11 Months |
| Towers (average) | 19 Months |
| KY Backspan Superstructure | 3 Months |
| IN Backspan Superstructure | 6 Months |
| Pier Tables | 2 Months |
| Mainspan Superstructure/Deck/Cables | 5 Months |
| Overlay, Barrier, Railing, Lighting | 3.5 Months |

***Bridge Construction Duration: 41 Months***

# TOWER CONSTRUCTION

8/1/2013

**FOUNDATIONS**

**4.5 Months** Precast Tubs

**8 Months** Drilled Shafts

**5 Months** Footings

2/29/2016

**12.5 Months** Solid Tower Lifts, Lifts 1-7

Hollow Tower Lifts, Lifts 8-16 **4 Months**

Hollow Lifts with Anchor Boxes, Lifts 17-22 **4.5 Months**

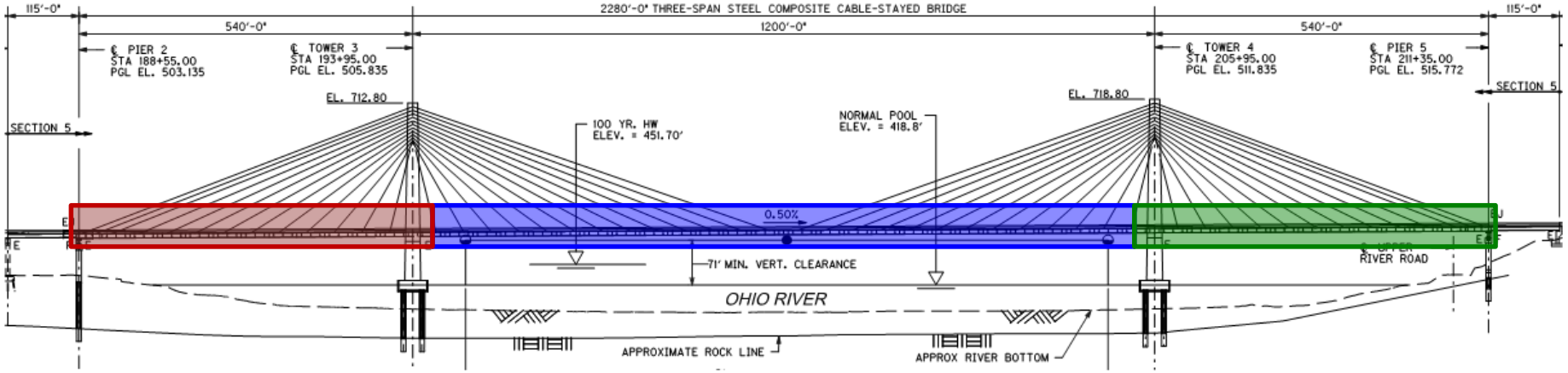
Upper Struts **2.5 Mo.**

**TOWERS**

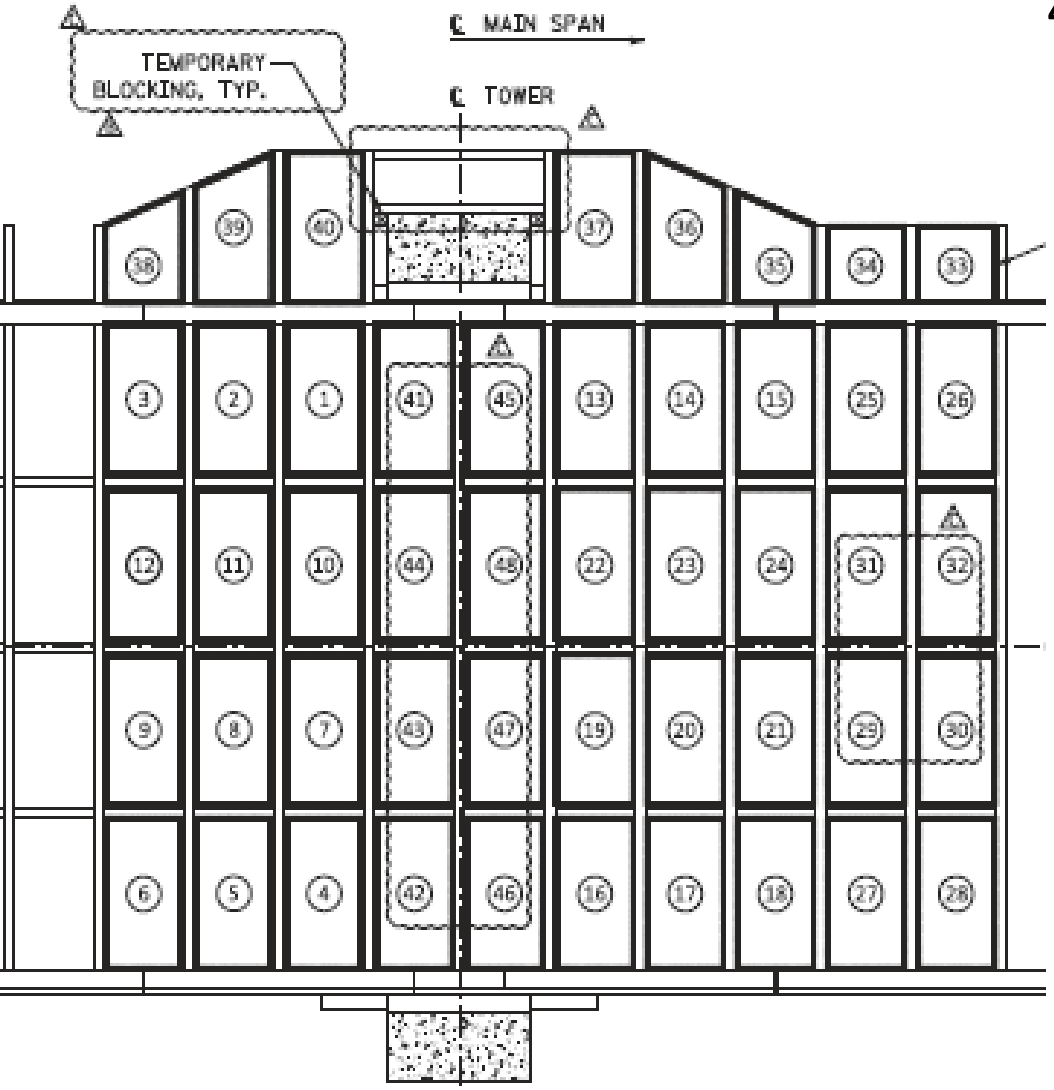
# ERECTION METHODS

- *1200’ MAIN SPAN:* ***BALANCED CANTILEVER***
- *540’ BACK SPANS:* ***STICK-BUILD ON FALSEWORK (KENTUCKY)***

  ***INCREMENTAL LAUNCH (INDIANA)***



# DECK ERECTION MANUAL




400 pages detailing:

- Structural Checks/ Assumed Loading
- Survey Requirements
- Deflections
- Work Points Coordinates
- Deck Elevations
- Stay Forces
- Support Reactions
- Detailed Cycle/Stay Stressing Sequence in 60 Erection Schematics

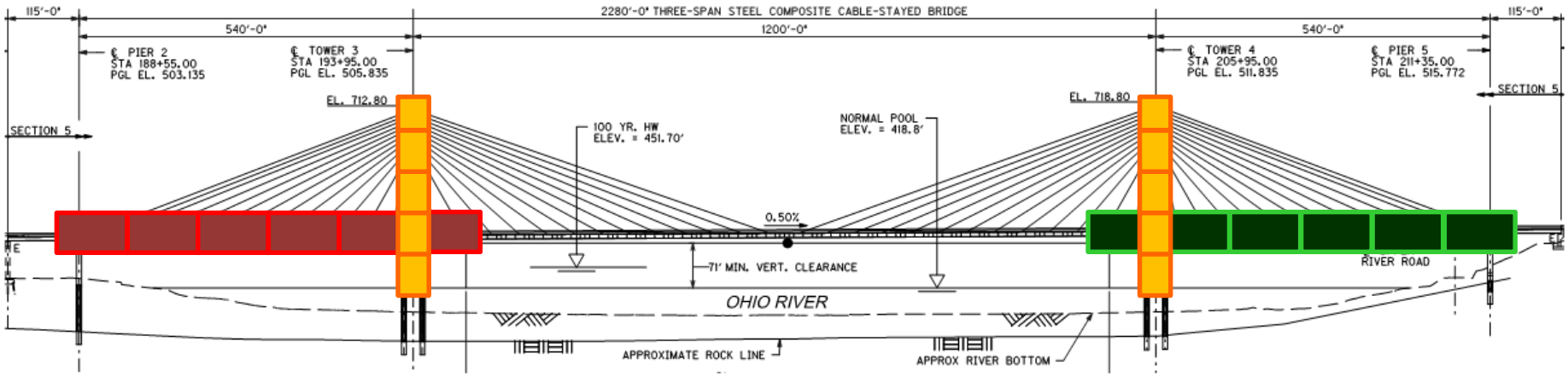
# BEST VALUE DELIVERED

- **RFP COMPLETION DATE = 7/1/2017**

**DATE PROPOSED :**

**10/31/2016**

# SCHEDULE LOGIC

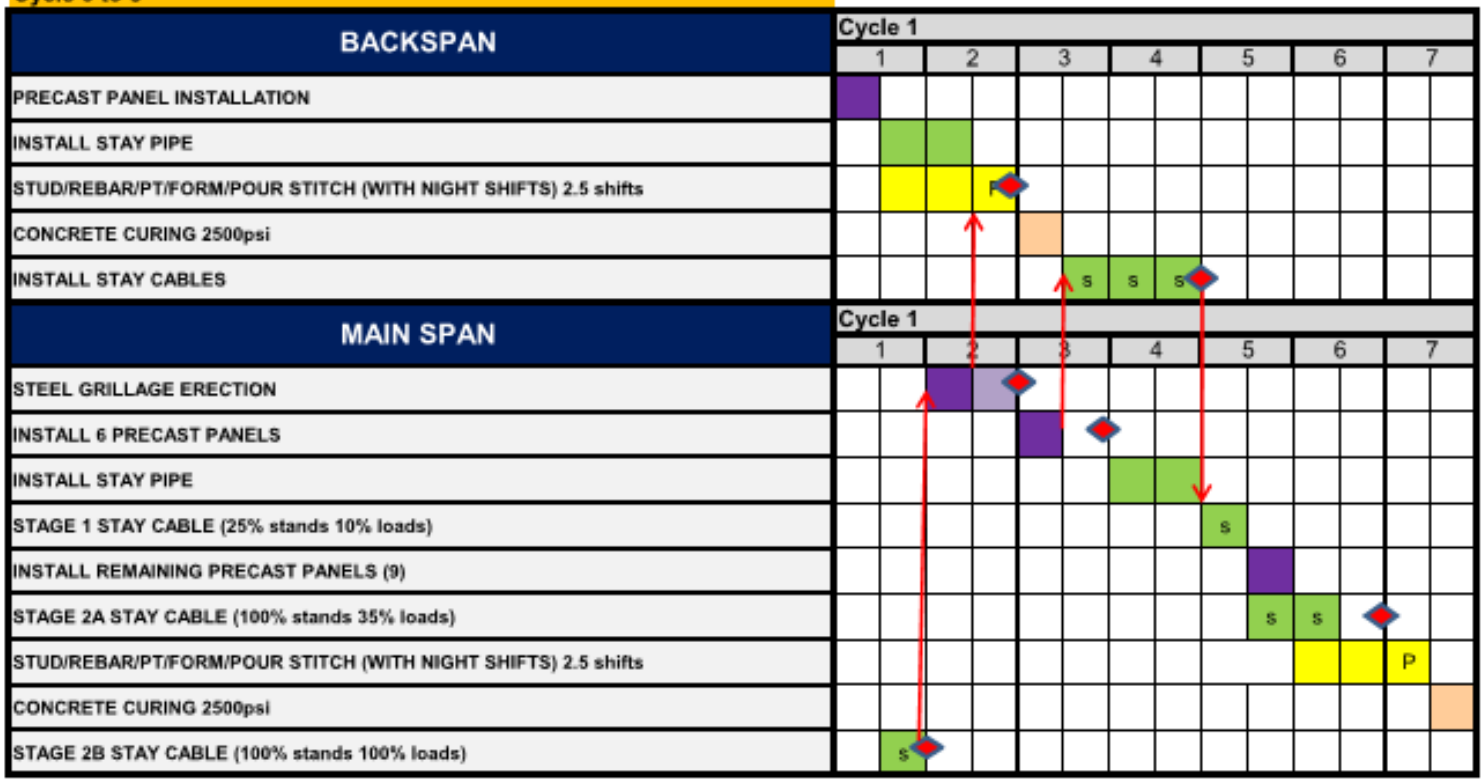



***OVERLAPPING ACTIVITIES = CRITICAL PATH GAINS***


THE OHIO RIVER
BRIDGES

# RESULT : OPTIMIZED CYCLES


**Cycle 3 to 8**



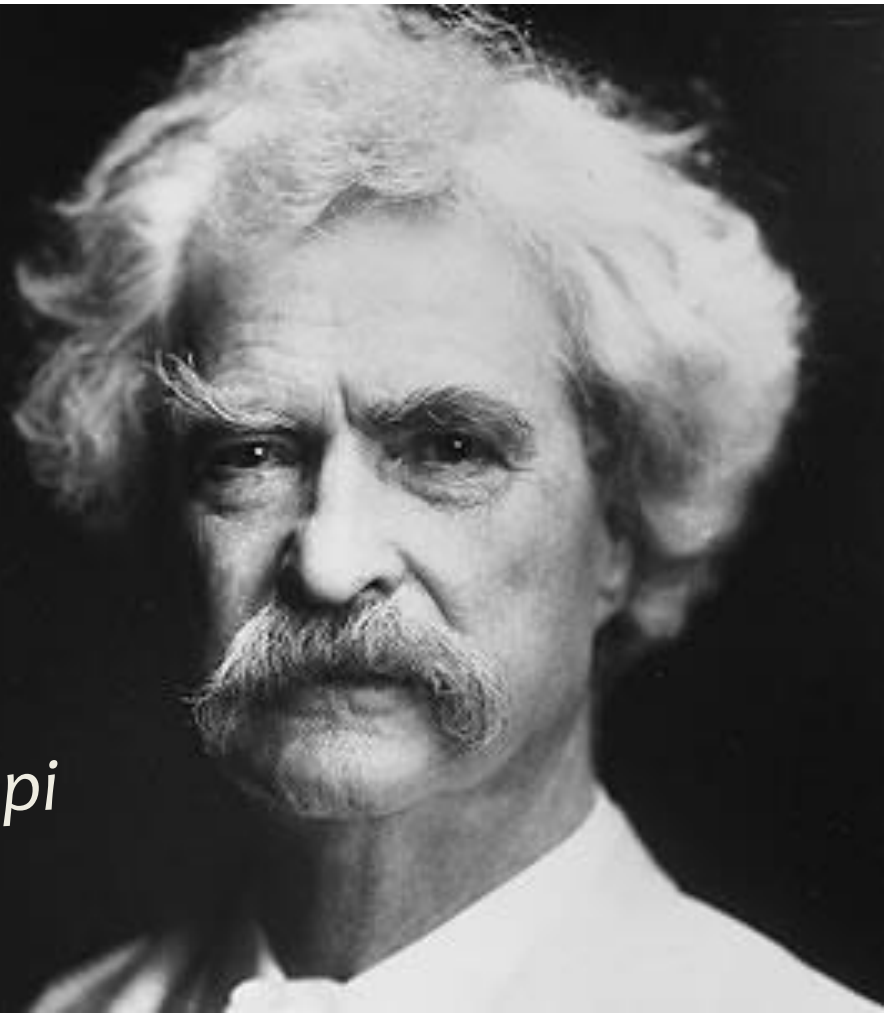
# LIFE ON THE OHIO ???

THE OHIO RIVER BRIDGES

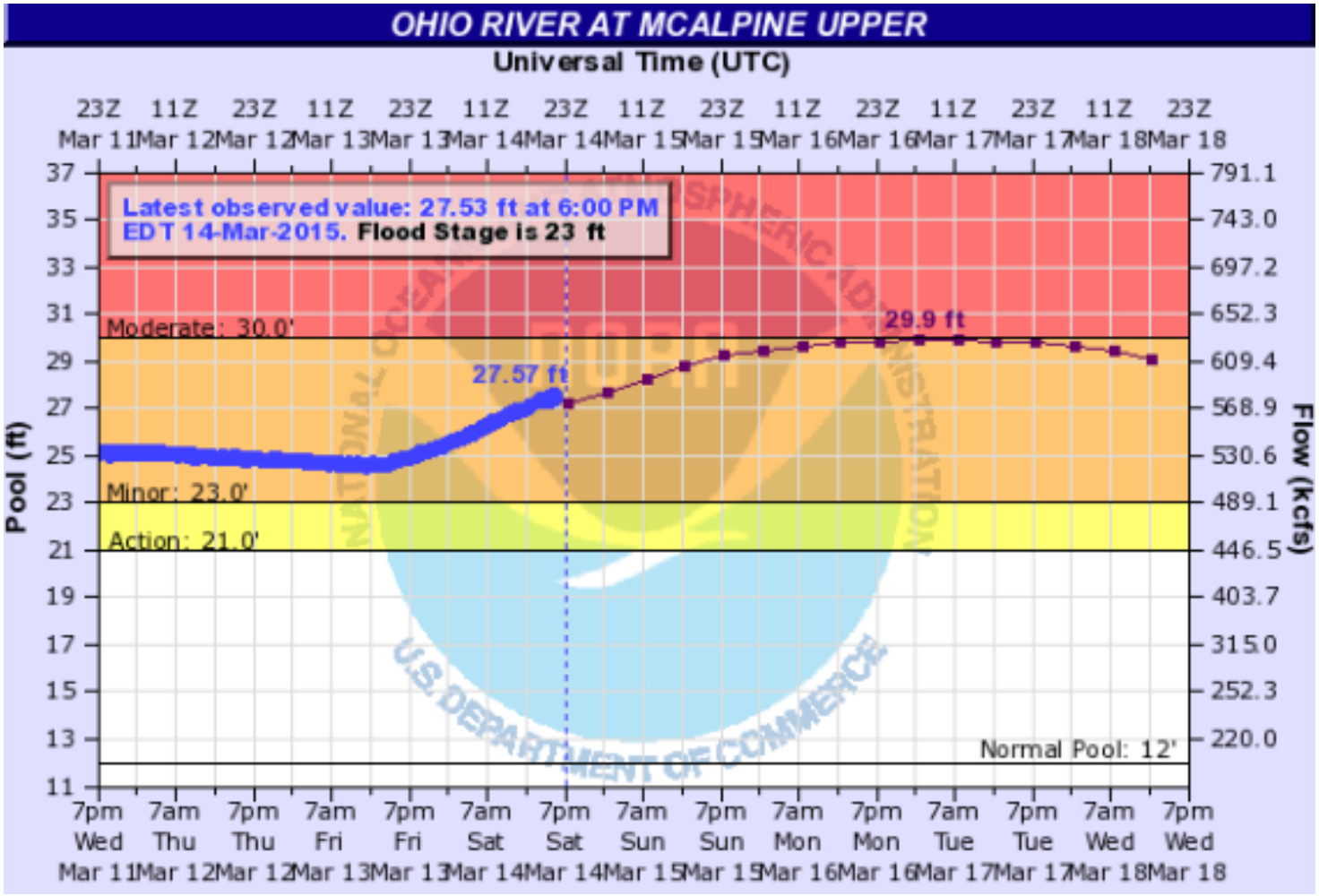
" Ship channels are buoyed and lighted, and therefore it is a comparatively easy undertaking to learn to run them. "

**- Mark Twain -**

*Life on the Mississippi*

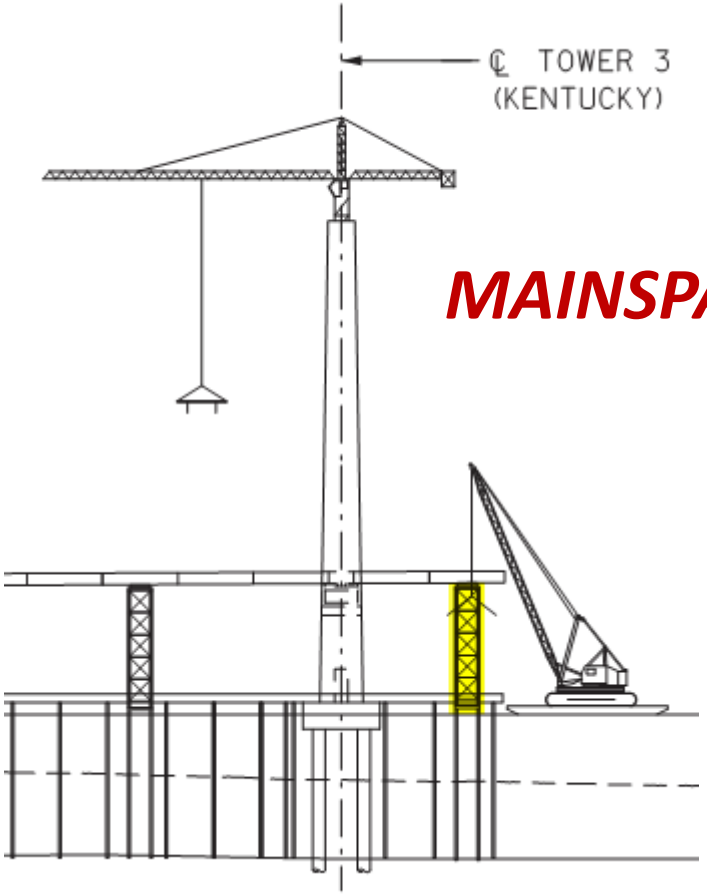


# LIFE ON THE OHIO



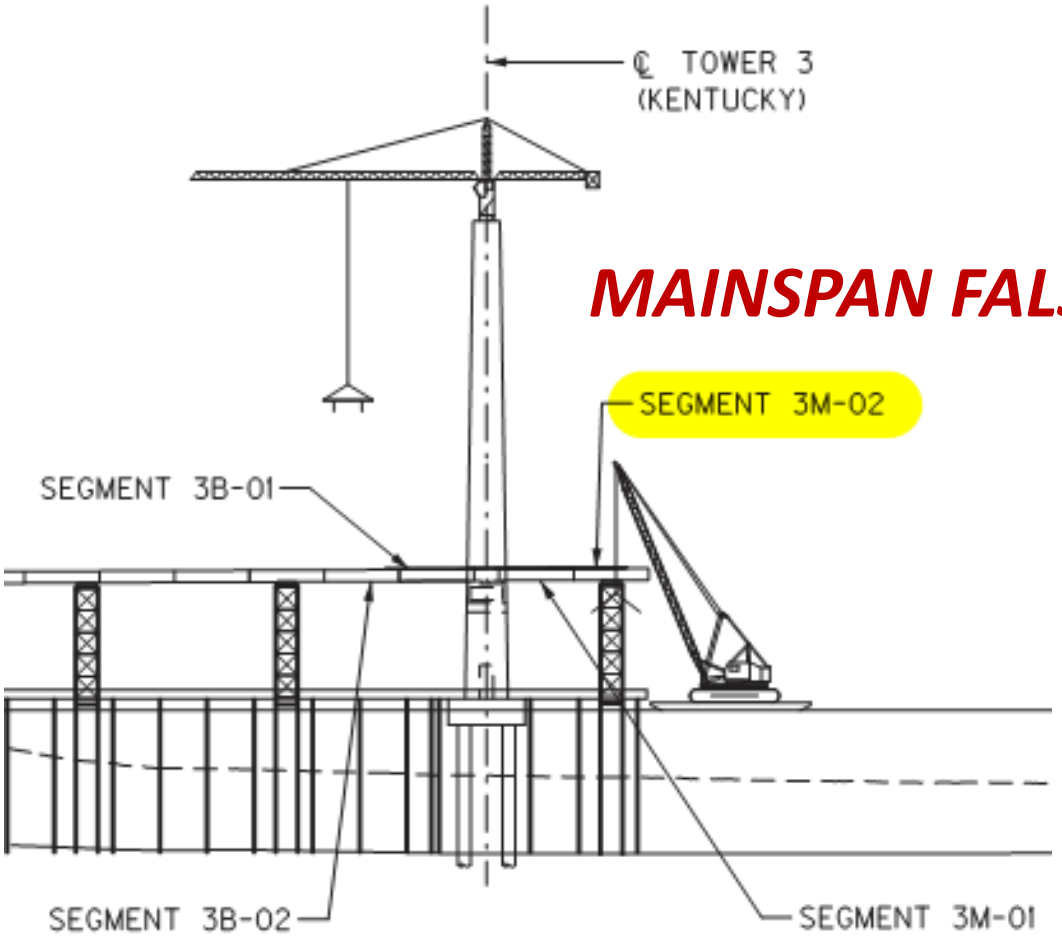

THE OHIO RIVER
BRIDGES

# SCHEDULE RECOVERY



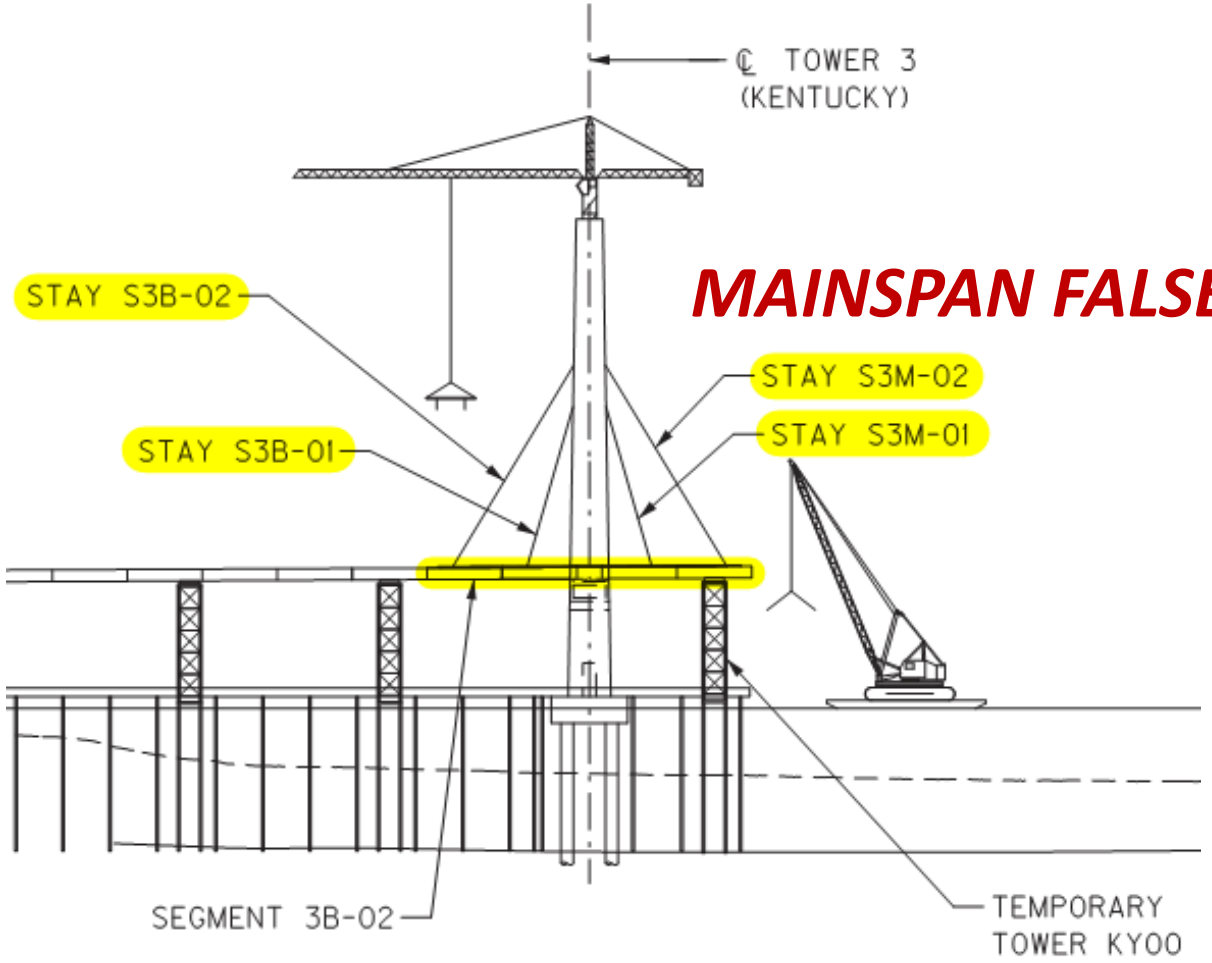

***MAINSPAN FALSEWORK***

# SCHEDULE RECOVERY




***MAINSPAN FALSEWORK***

# RESULT: EARLY PANELS

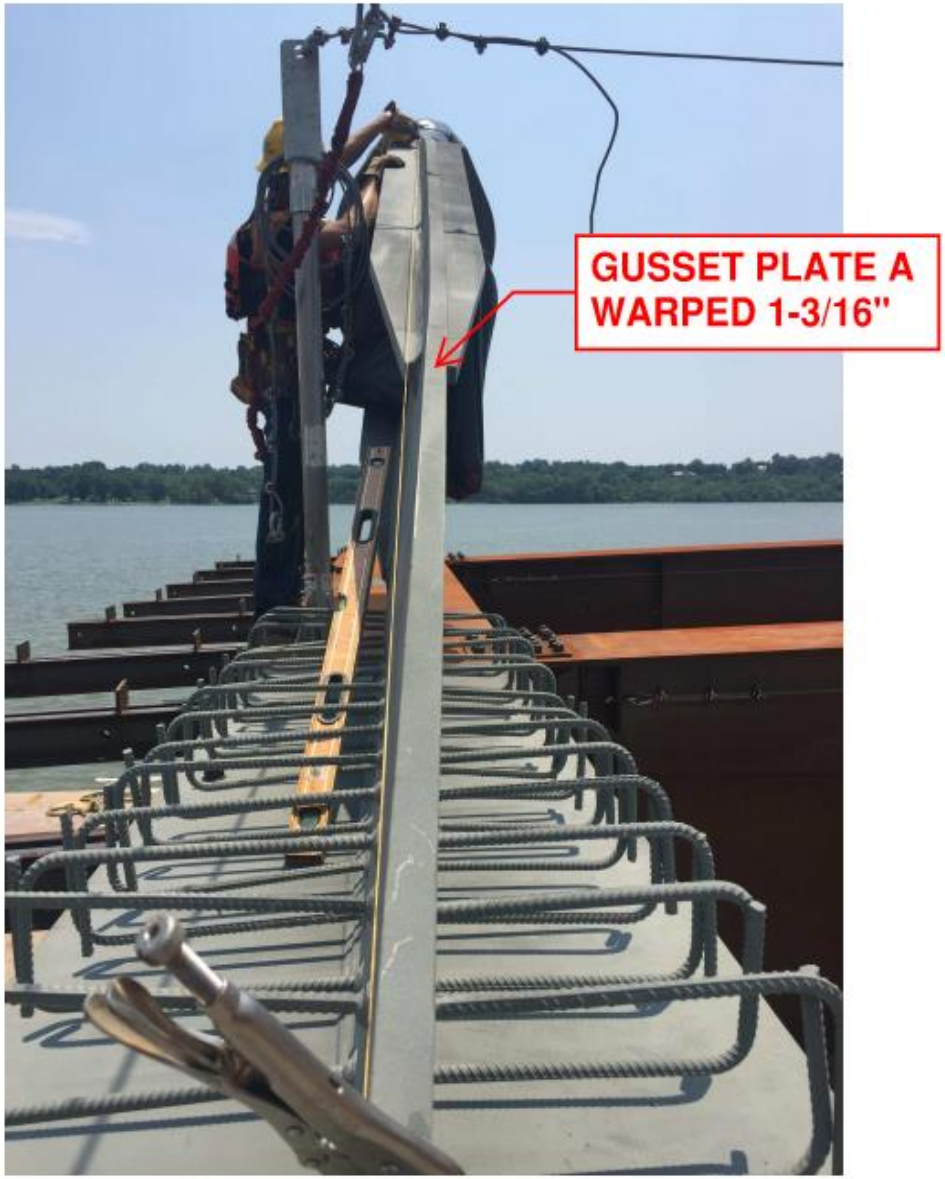


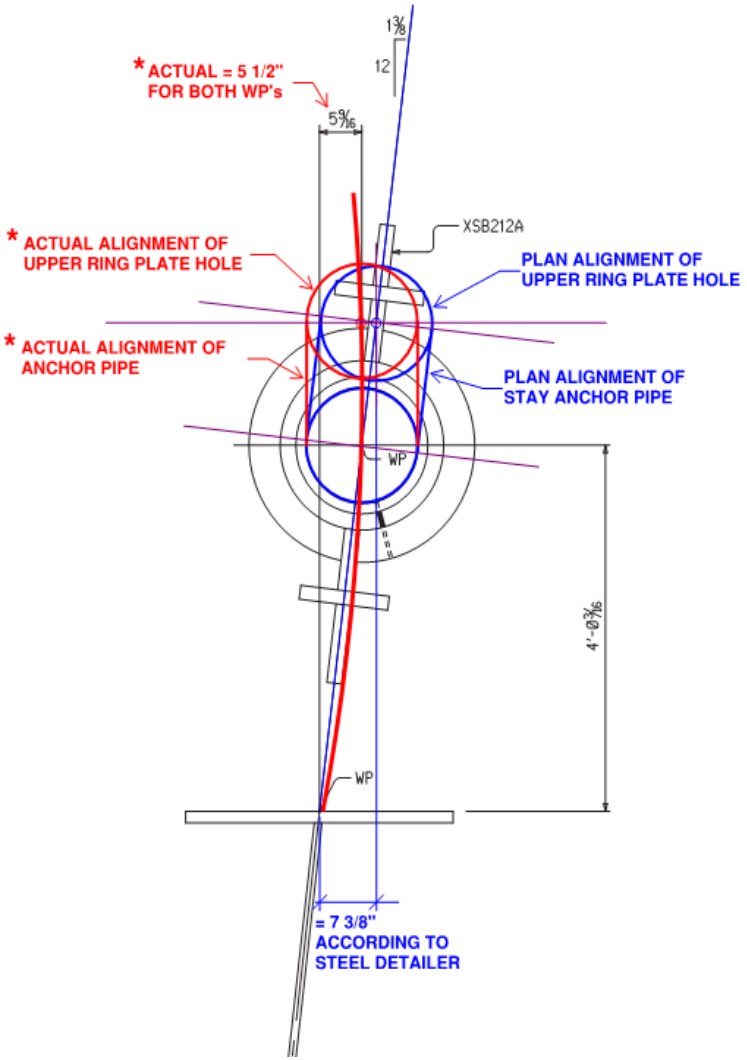

***MAINSPAN FALSEWORK***


THE OHIO RIVER
BRIDGES

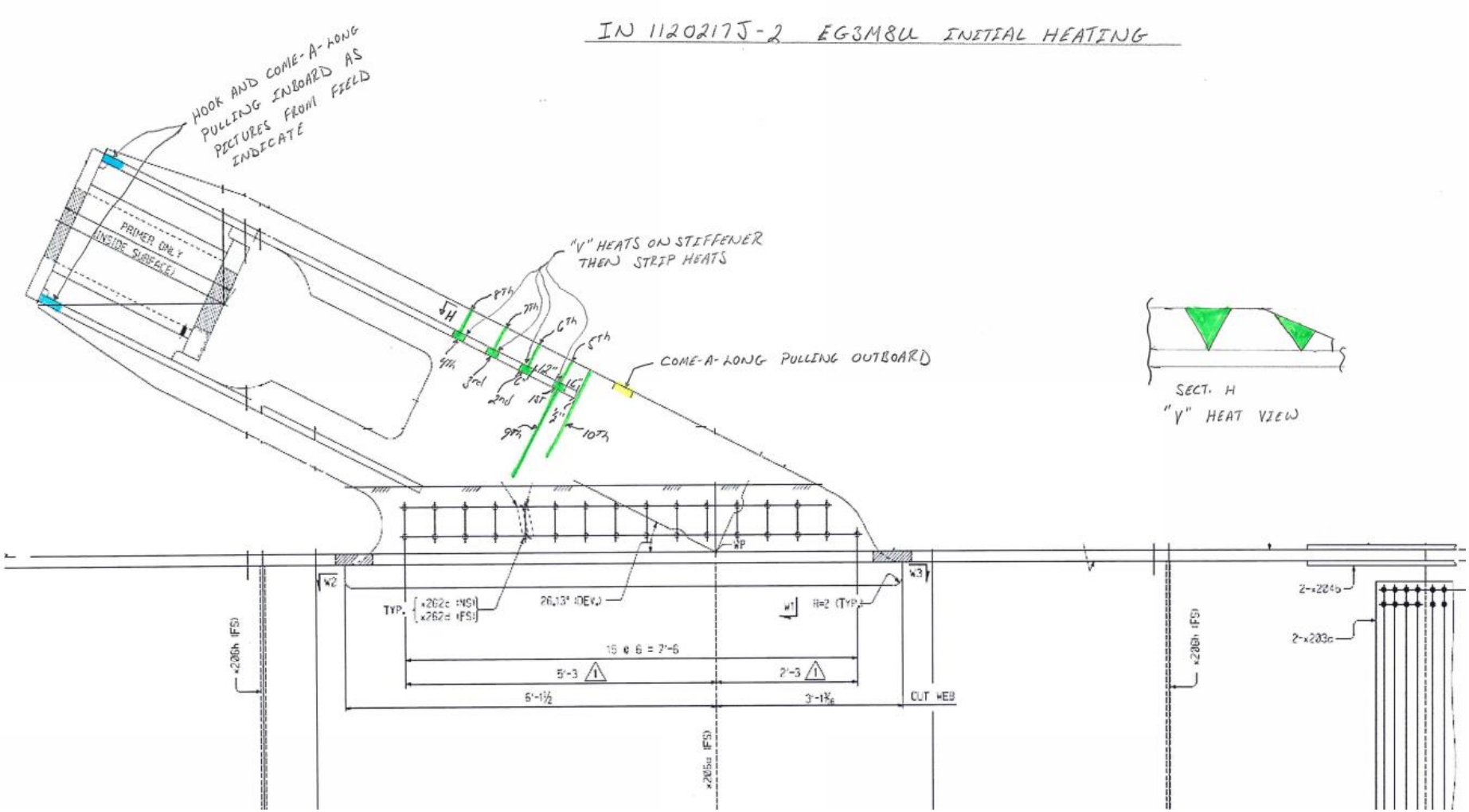
# UNFORESEEN OBSTACLES

# STAY GEOMETRY



# HEAT STRAIGHTENING

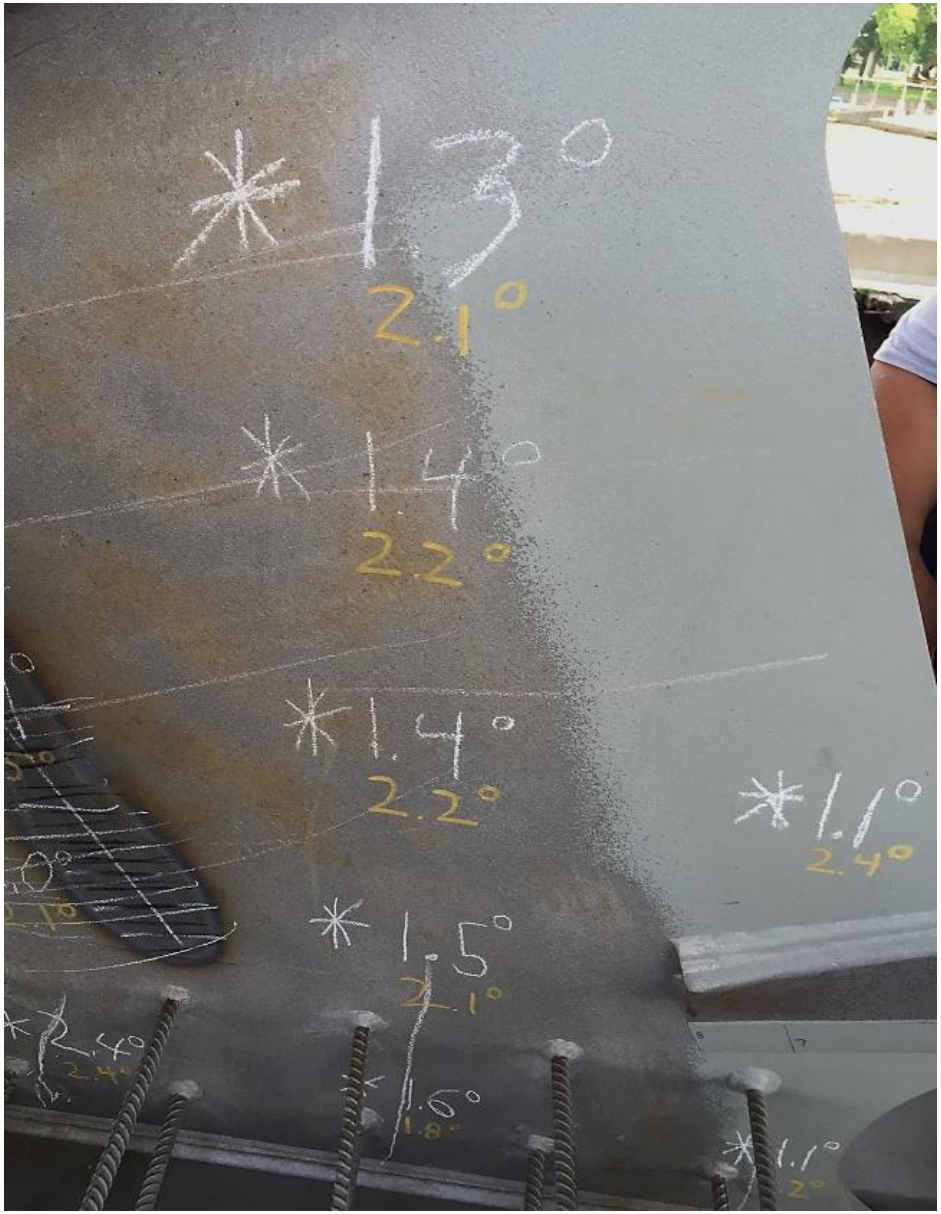


# HEAT STRAIGHTENING

THE OHIO RIVER BRIDGES

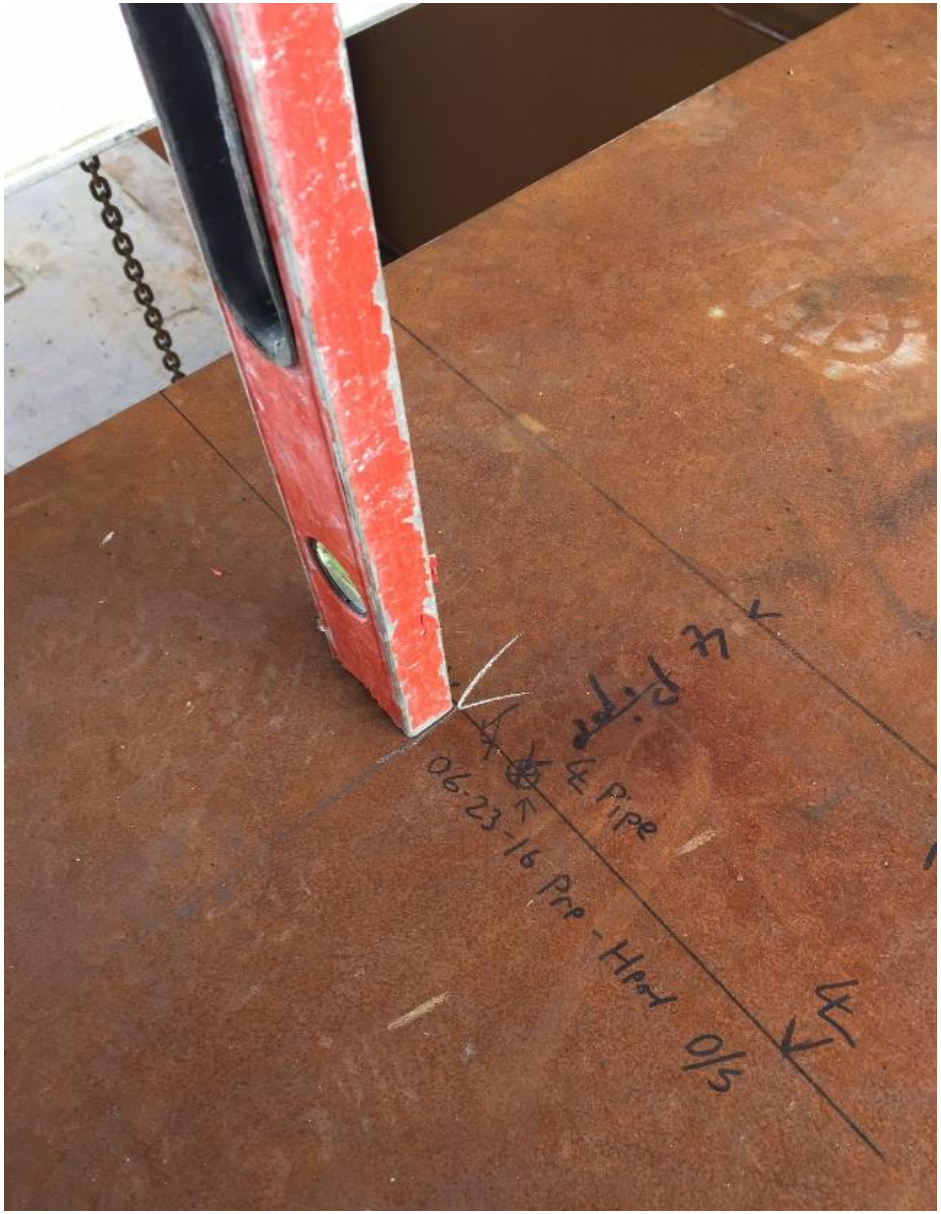

# HEAT STRAIGHTENING

THE OHIO RIVER BRIDGES



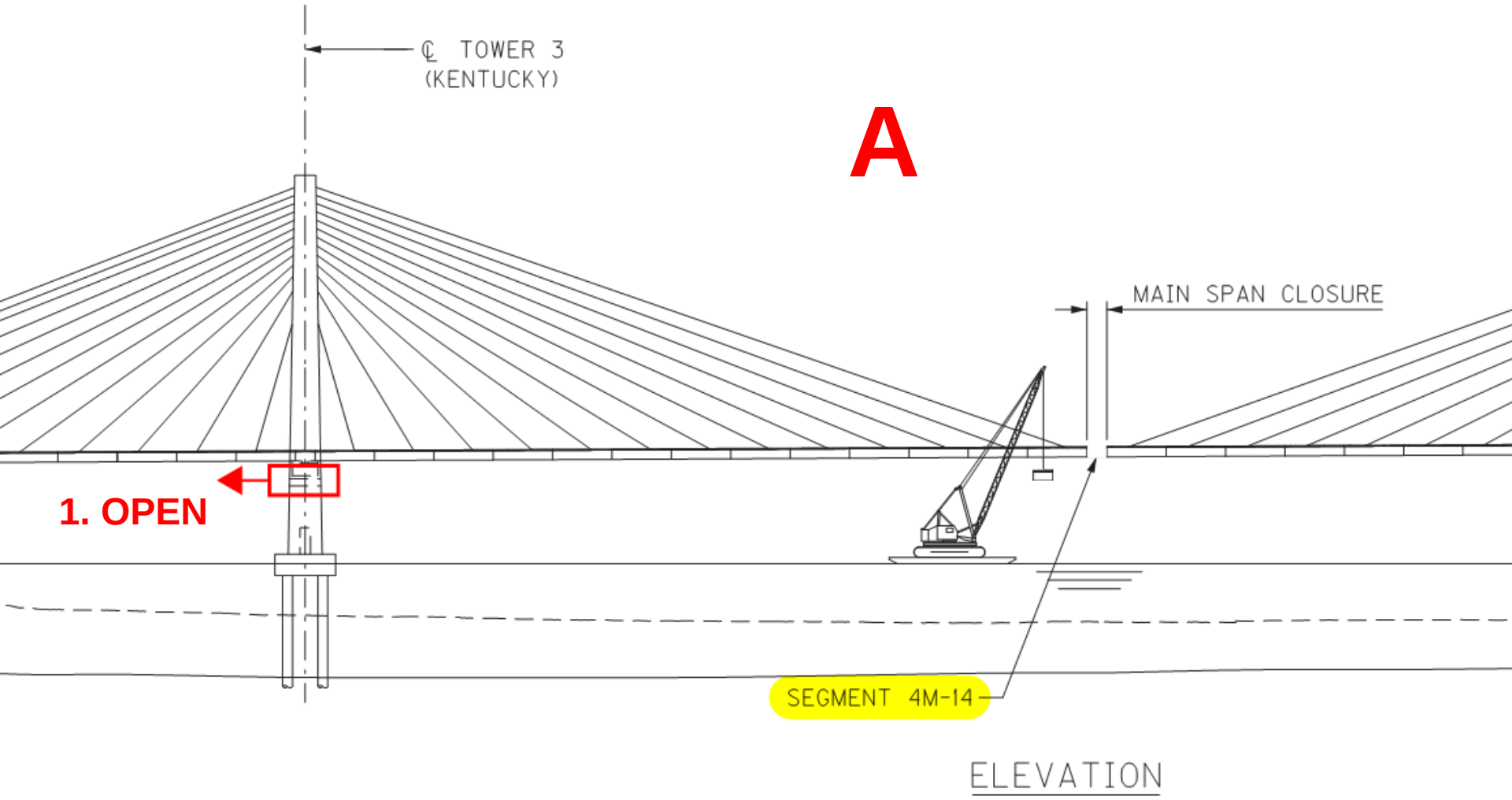
# HEAT STRAIGHTENING

THE OHIO RIVER BRIDGES

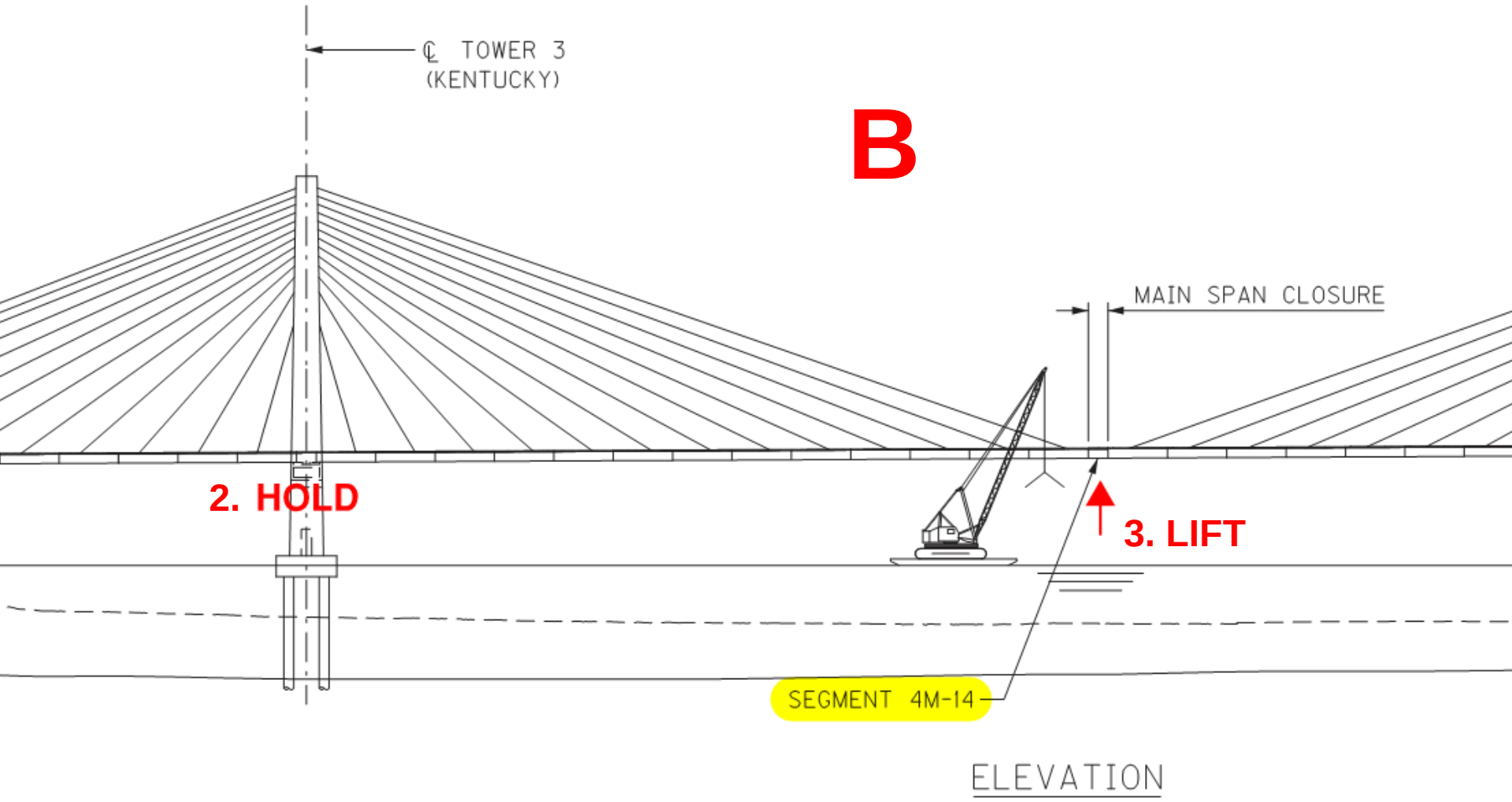


# FINISHING STRONG

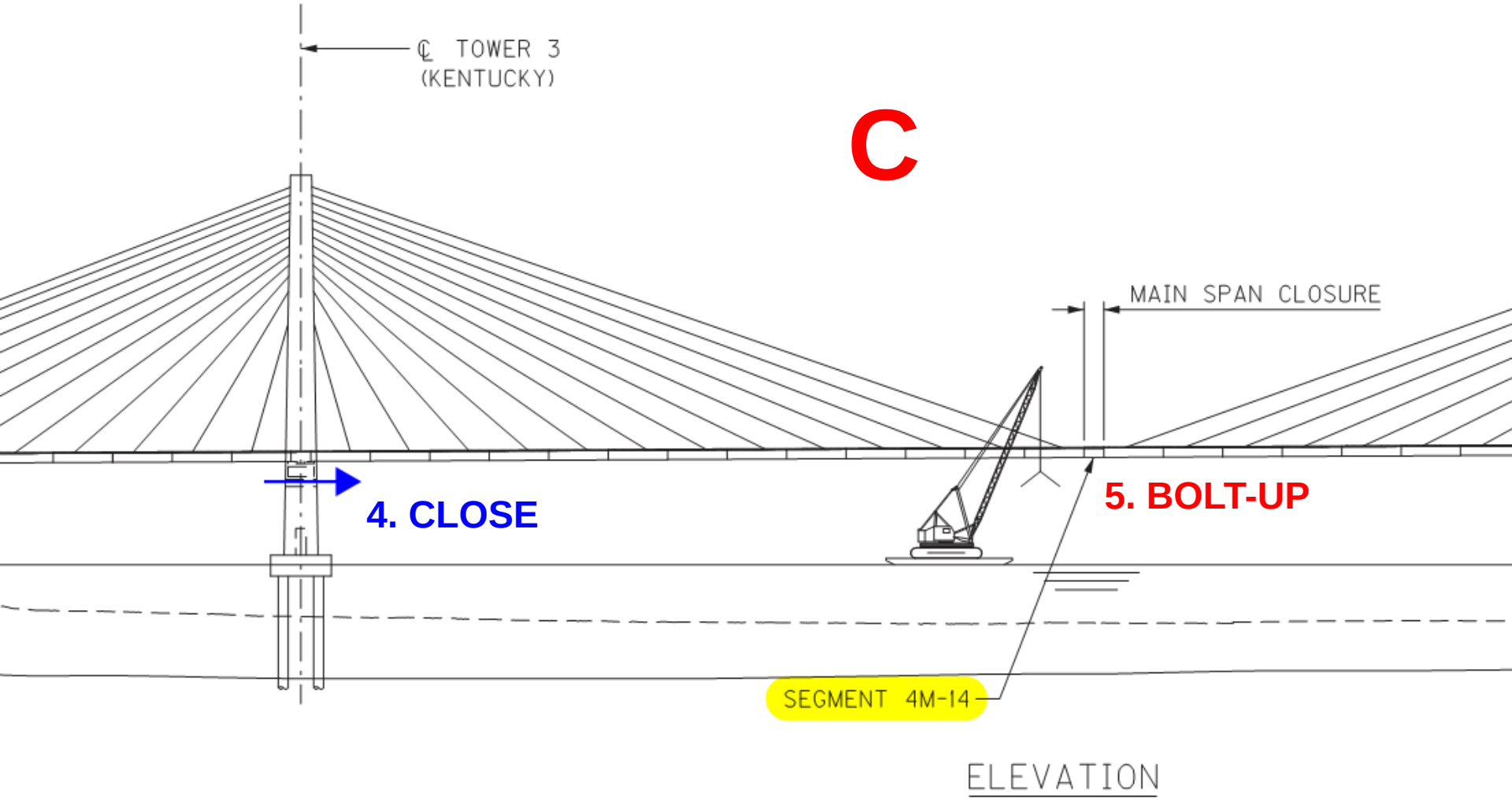
# CLOSURE DETAILING



# CLOSURE DETAILING



# CLOSURE DETAILING




THE OHIO RIVER
BRIDGES
JLG LIFT


THE OHIO RIVER
BRIDGES
SAFE
ON-TIME

# CABLE-STAYED BRIDGE THEORY

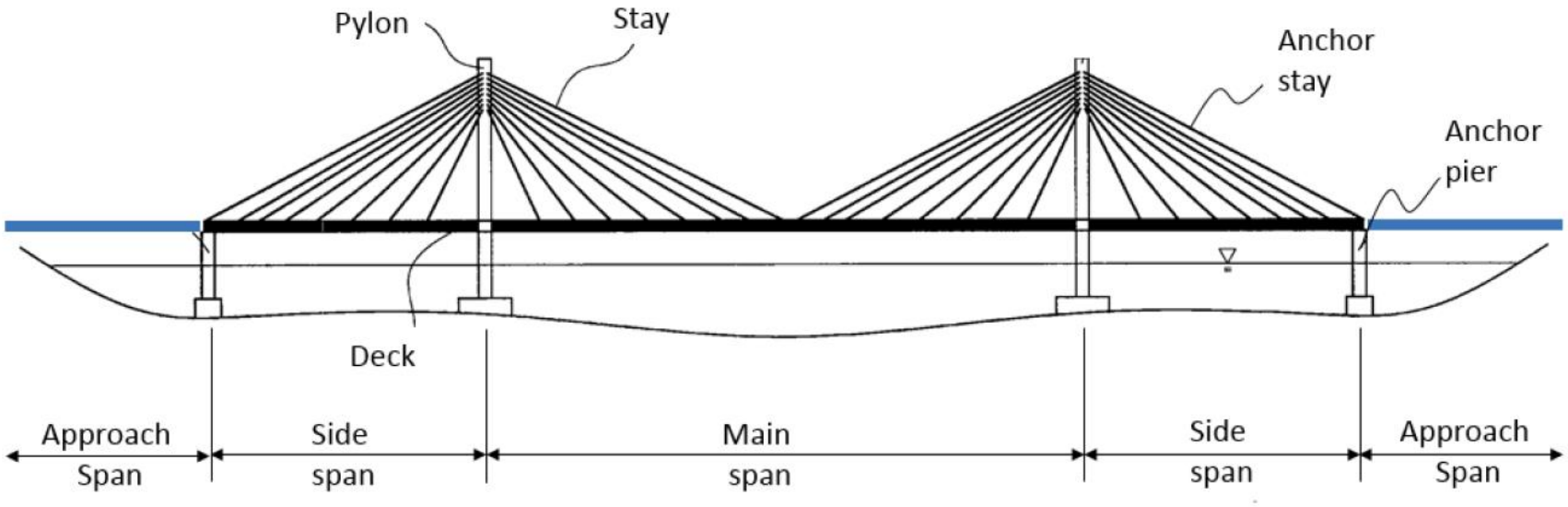
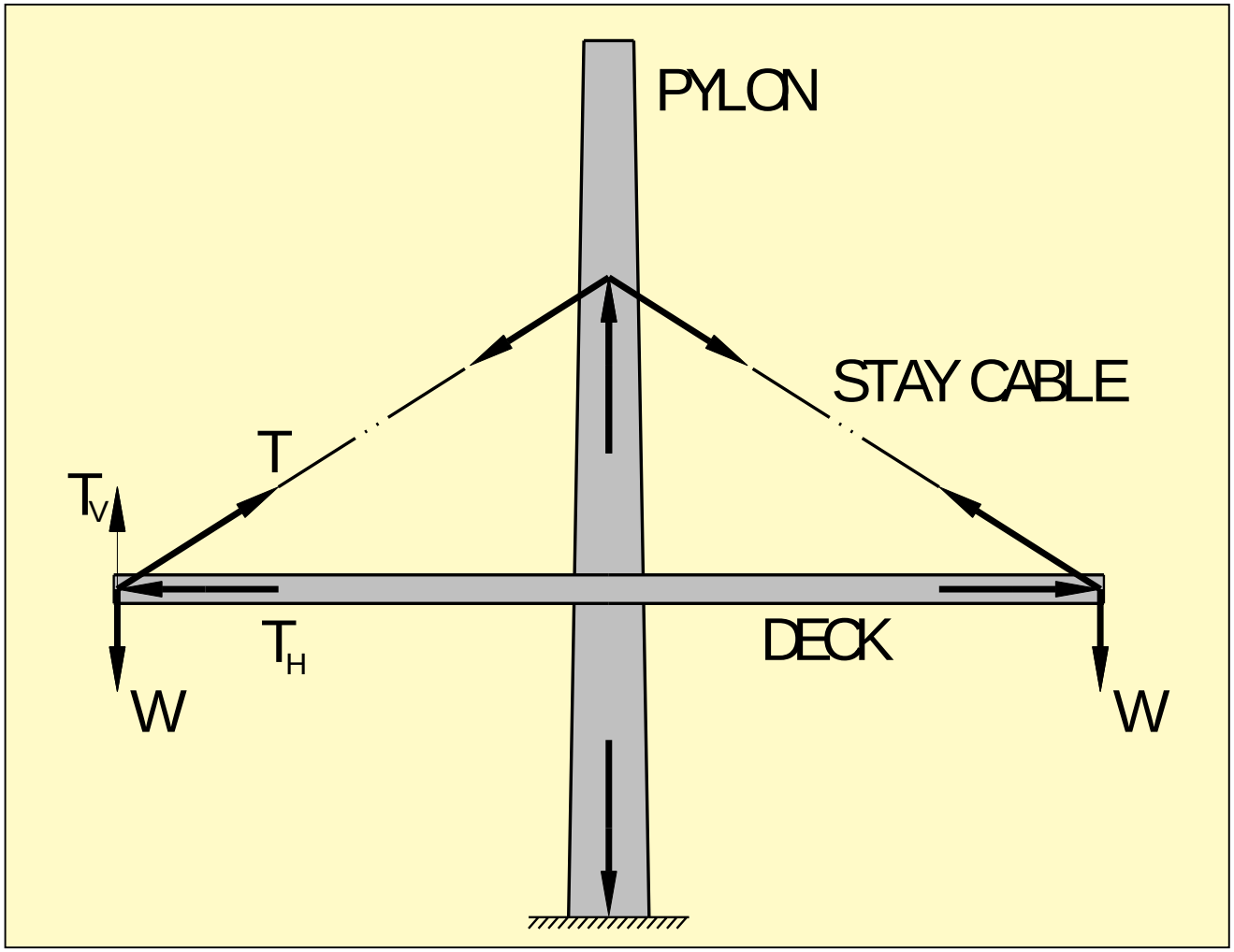



*Figure 5, Components of a typical cable-stayed bridge*

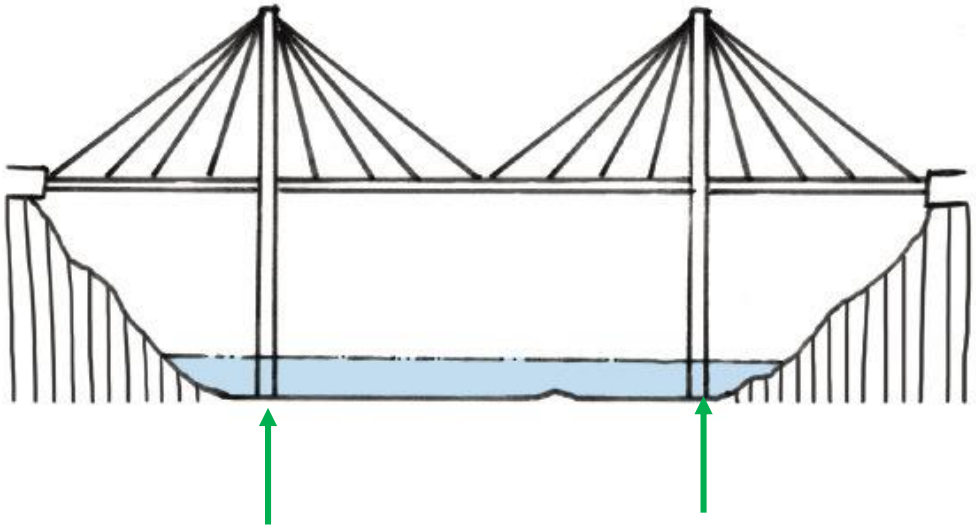
Cable-Stayed Bridge Nomenclature

# CABLE-STAYED BRIDGE THEORY

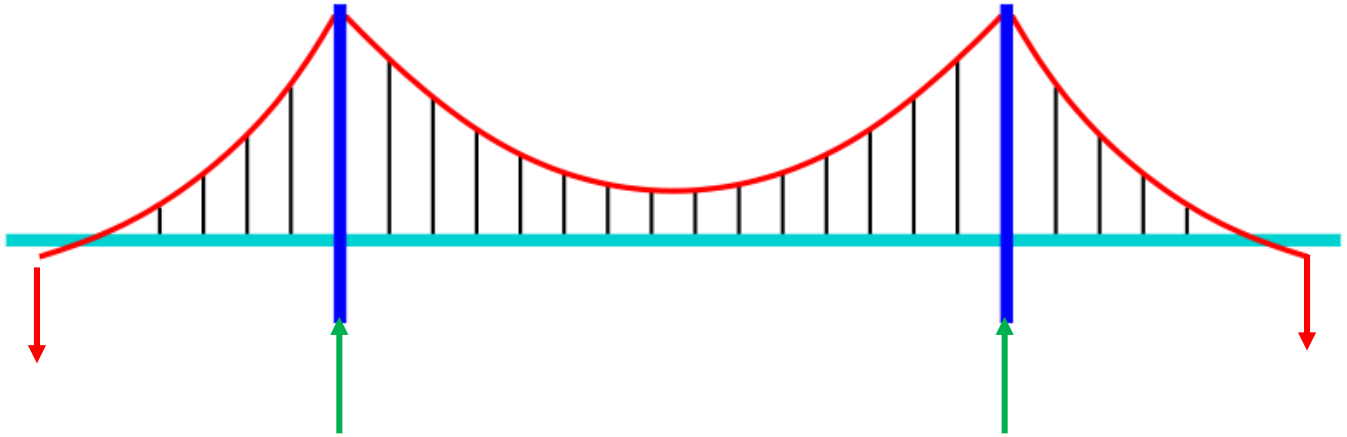



Triangular load path

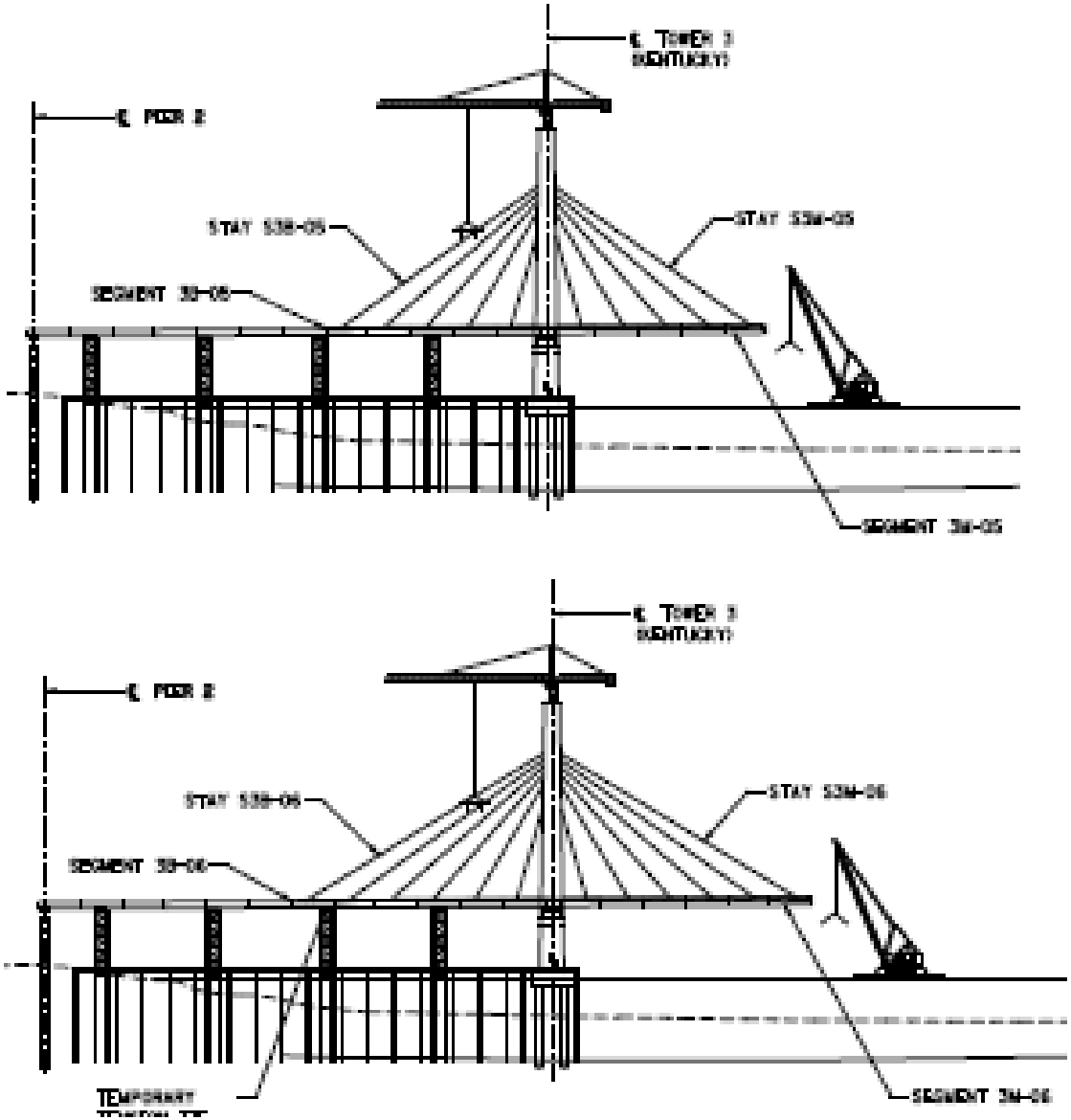
# CABLE-STAYED BRIDGE THEORY



Cable-stay vs suspension reactions



# CABLE-STAYED CONSTRUCTION



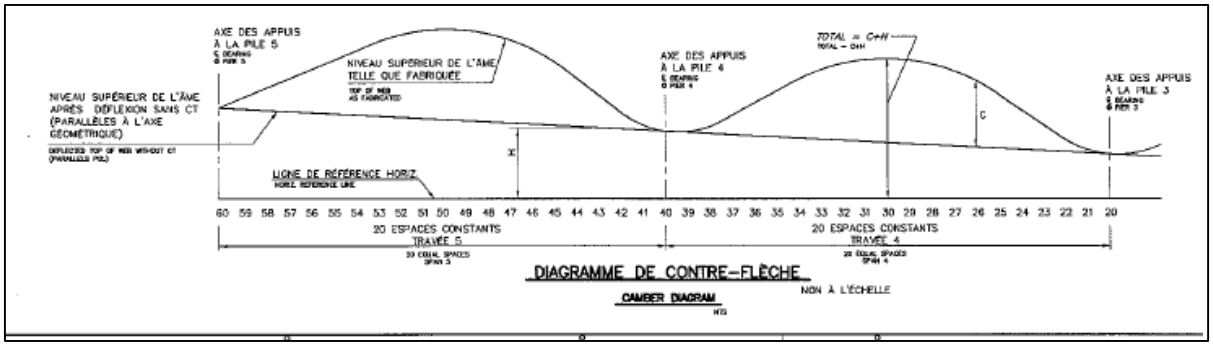

The final state drives the construction sequence.

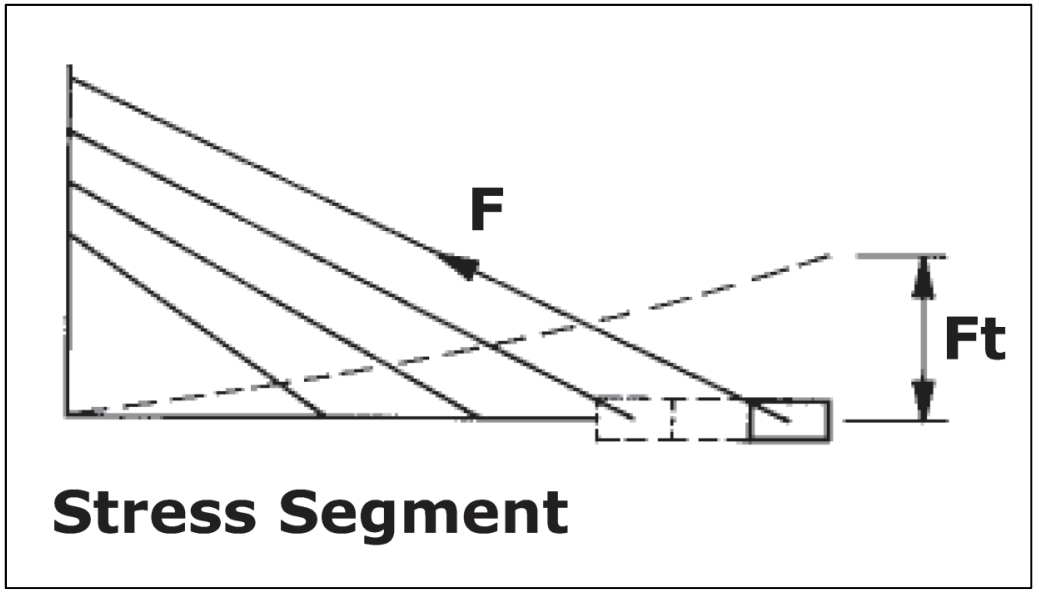
# CONSTRUCTION ENGINEERING

Construction engineering of a cable-stayed bridge is a complex undertaking, but the essence of the job can be distilled to three things:

- Get the bridge in the right place
- Get the right force in the stays
- Don’t break anything

# GEOMETRY CONTROL




Active vs passive geometry control

# GEOMETRY CONTROL

Things move often.

Things move a lot.

**Downstream (D) Edge Girder Survey Control Point Elevations (ft)**

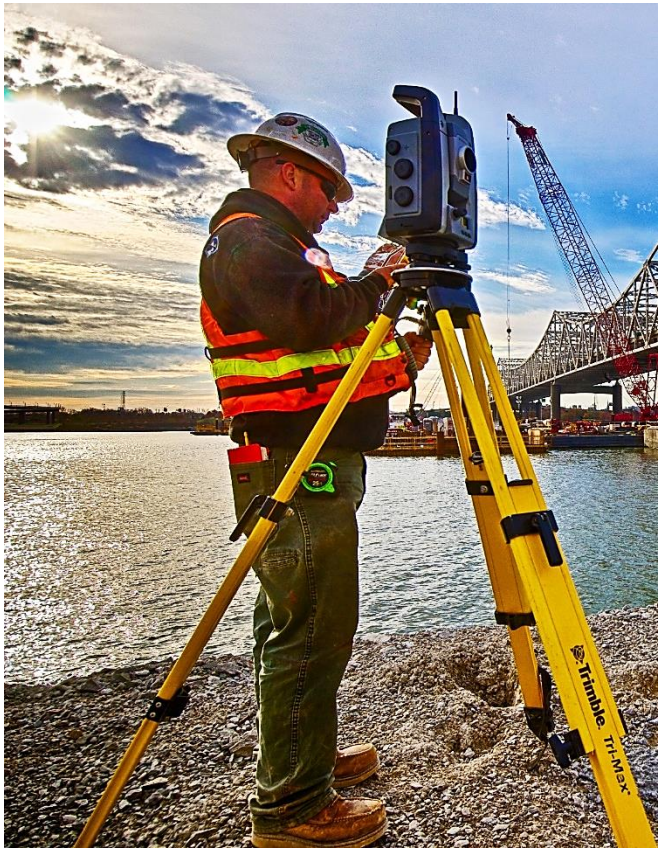
Including Camber

| | | | | | | | | | | | | | | CL Main Span |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Construction Step | Construction Activity | SP3M-1 | SP3M-2 | SP3M-3 | SP3M-4 | SP3M-5 | SP3M-6 | SP3M-7 | SP3M-8 | SP3M-9 | SP3M-10 | SP3M-11 | SP3M-12 | SP3M-13 |
| Step 76 | Lift T3M-07: Cast CIP Stitch | 503.893 | 504.185 | 504.496 | 504.789 | 505.033 | 505.230 | 505.414 | - | - | - | - | - | - |
| Step 77 | Lift T3M-07: Re-Stress Stays (2) | 503.880 | 504.164 | 504.495 | 504.870 | 505.302 | 505.809 | 506.395 | - | - | - | - | - | - |
| Step 78 | Lift T3B-08: Cast CIP Stitch | 503.883 | 504.170 | 504.503 | 504.882 | 505.316 | 505.827 | 506.416 | - | - | - | - | - | - |
| Step 79 | Lift T3B-08: Install & Stress Stays (1) | 503.962 | 504.333 | 504.753 | 505.222 | 505.747 | 506.349 | 507.031 | - | - | - | - | - | - |
| Step 80 | Lift T3M-08: Position New Grillage Segment | 503.962 | 504.333 | 504.753 | 505.222 | 505.747 | 506.349 | 507.031 | 507.730 | - | - | - | - | - |
| Step 81 | Lift T3M-08: Stress Diagonal Bracing | 503.952 | 504.312 | 504.717 | 505.153 | 505.616 | 506.109 | 506.627 | 507.092 | - | - | - | - | - |
| Step 82 | Lift T3M-08: Place First 6 Precast Panels | 503.937 | 504.282 | 504.663 | 505.055 | 505.432 | 505.780 | 506.086 | 506.269 | - | - | - | - | - |
| Step 83 | Lift T3M-08: Install & Stress Partial Stays (1A) | 503.935 | 504.278 | 504.658 | 505.053 | 505.443 | 505.818 | 506.169 | 506.429 | - | - | - | - | - |
| Step 84 | Lift T3M-08: Place Remlaining Precast Panels | 503.917 | 504.239 | 504.591 | 504.933 | 505.225 | 505.438 | 505.557 | 505.526 | - | - | - | - | - |
| Step 85 | Lift T3B-09: Place Precast Panels | 503.915 | 504.237 | 504.587 | 504.928 | 505.218 | 505.430 | 505.547 | 505.515 | - | - | - | - | - |
| Step 86 | Lift T3M-08: Install & Stress Full Stays (1B) | 503.910 | 504.225 | 504.571 | 504.922 | 505.249 | 505.541 | 505.792 | 505.984 | - | - | - | - | - |
| Step 87 | Lift T3M-08: Re-Stress Full Stays (1C) | 503.909 | 504.222 | 504.569 | 504.922 | 505.260 | 505.572 | 505.857 | 506.106 | - | - | - | - | - |
| Step 88 | Lift T3M-08: Cast CIP Stitch | 503.899 | 504.201 | 504.534 | 504.867 | 505.172 | 505.436 | 505.662 | 505.858 | - | - | - | - | - |
| Step 89 | Lift T3M-08: Re-Stress Stays (2) | 503.889 | 504.179 | 504.509 | 504.876 | 505.289 | 505.772 | 506.341 | 506.964 | - | - | - | - | - |
| Step 90 | Lift T3B-09: Cast CIP Stitch | 503.889 | 504.179 | 504.509 | 504.876 | 505.288 | 505.771 | 506.340 | 506.963 | - | - | - | - | - |
| Step 91 | Lift T3B-09: Install & Stress Stays (1) | 503.958 | 504.322 | 504.728 | 505.173 | 505.666 | 506.231 | 506.883 | 507.590 | - | - | - | - | - |
| Step 92 | Lift T3M-09: Position New Grillage Segment | 503.958 | 504.322 | 504.728 | 505.173 | 505.666 | 506.231 | 506.883 | 507.590 | 508.306 | - | - | - | - |
| Step 93 | Lift T3M-09: Stress Diagonal Bracing | 503.949 | 504.304 | 504.701 | 505.130 | 505.585 | 506.078 | 506.608 | 507.139 | 507.611 | - | - | - | - |
| Step 94 | Lift T3M-09: Place First 6 Precast Panels | 503.935 | 504.279 | 504.662 | 505.065 | 505.469 | 505.862 | 506.231 | 506.537 | 506.713 | - | - | - | - |
| Step 95 | Lift T3M-09: Install & Stress Partial Stays (1A) | 503.934 | 504.276 | 504.657 | 505.060 | 505.469 | 505.876 | 506.272 | 506.620 | 506.865 | - | - | - | - |
| Step 96 | Lift T3M-09: Place Remlaining Precast Panels | 503.918 | 504.243 | 504.607 | 504.979 | 505.326 | 505.619 | 505.830 | 505.912 | 505.848 | - | - | - | - |
| Step 97 | Lift T3B-10: Place Precast Panels | 503.917 | 504.242 | 504.604 | 504.976 | 505.322 | 505.614 | 505.824 | 505.915 | 505.841 | - | - | - | - |
| Step 98 | Lift T3M-09: Install & Stress Full Stays (1B) | 503.912 | 504.231 | 504.586 | 504.957 | 505.321 | 505.664 | 505.974 | 506.223 | 506.409 | - | - | - | - |
| Step 99 | Lift T3M-09: Re-Stress Full Stays (1C) | 503.912 | 504.229 | 504.583 | 504.954 | 505.323 | 505.679 | 506.014 | 506.300 | 506.545 | - | - | - | - |
| Step 100 | Lift T3M-09: Cast CIP Stitch | 503.903 | 504.212 | 504.556 | 504.913 | 505.259 | 505.580 | 505.863 | 506.087 | 506.278 | - | - | - | - |
| Step 101 | Lift T3M-09: Re-Stress Stays (2) | 503.896 | 504.192 | 504.525 | 504.887 | 505.287 | 505.748 | 506.292 | 506.900 | 507.562 | - | - | - | - |
| Step 102 | Lift T3B-10: Cast CIP Stitch | 503.896 | 504.192 | 504.524 | 504.886 | 505.285 | 505.746 | 506.290 | 506.898 | 507.561 | - | - | - | - |
| Step 103 | Lift T3B-10: Install & Stress Stays (1) | 503.949 | 504.301 | 504.691 | 505.113 | 505.574 | 506.099 | 506.707 | 507.381 | 508.110 | - | - | - | - |
| Step 104 | Lift T3M-10: Position New Grillage Segment | 503.949 | 504.301 | 504.691 | 505.113 | 505.574 | 506.099 | 506.707 | 507.381 | 508.110 | 508.849 | - | - | - |
| Step 105 | Lift T3M-10: Stress Diagonal Bracing | 503.939 | 504.283 | 504.667 | 505.080 | 505.520 | 506.001 | 506.527 | 507.071 | 507.614 | 508.100 | - | - | - |
| Step 106 | Lift T3M-10: Place First 6 Precast Panels | 503.926 | 504.259 | 504.632 | 505.031 | 505.442 | 505.861 | 506.275 | 506.646 | 506.952 | 507.129 | - | - | - |
| Step 107 | Lift T3M-10: Install & Stress Partial Stays (1A) | 503.925 | 504.256 | 504.627 | 505.024 | 505.436 | 505.862 | 506.295 | 506.698 | 507.052 | 507.309 | - | - | - |
| Step 108 | Lift T3M-10: Place Remlaining Precast Panels | 503.909 | 504.225 | 504.582 | 504.961 | 505.338 | 505.692 | 505.996 | 506.203 | 506.291 | 506.219 | - | - | - |
| Step 109 | Remove Temporary Tower KY03 | 503.914 | 504.235 | 504.597 | 504.982 | 505.364 | 505.724 | 506.034 | 506.247 | 506.340 | 506.274 | - | - | - |
| Step 110 | Remove Temporary Tower KY04 | 503.924 | 504.256 | 504.630 | 505.026 | 505.421 | 505.793 | 506.116 | 506.341 | 506.447 | 506.394 | - | - | - |
| Step 111 | Lift T3B-11: Place Precast Panels | 503.966 | 504.345 | 504.769 | 505.216 | 505.662 | 506.086 | 506.462 | 506.740 | 506.899 | 506.900 | - | - | - |
| Step 112 | Lift T3M-10: Install & Stress Full Stays (1B) | 503.960 | 504.332 | 504.746 | 505.185 | 505.631 | 506.076 | 506.506 | 506.884 | 507.197 | 507.450 | - | - | - |
| Step 113 | Lift T3M-10: Re-Stress Full Stays (1C) | 503.960 | 504.331 | 504.743 | 505.181 | 505.628 | 506.080 | 506.525 | 506.927 | 507.279 | 507.593 | - | - | - |
| Step 114 | Lift T3M-10: Cast CIP Stitch | 503.938 | 504.285 | 504.673 | 505.083 | 505.498 | 505.906 | 506.293 | 506.623 | 506.889 | 507.124 | - | - | - |
| Step 115 | Lift T3M-10: Re-Stress Stays (2) | 503.935 | 504.275 | 504.650 | 505.052 | 505.484 | 505.971 | 506.534 | 507.164 | 507.863 | 508.625 | - | - | - |
| Step 116 | Lift T3B-11: Cast CIP Stitch | 503.948 | 504.301 | 504.690 | 505.106 | 505.553 | 506.055 | 506.633 | 507.279 | 507.994 | 508.772 | - | - | - |
| Step 117 | Lift T3B-11: Install & Stress Stays (1) | 504.018 | 504.447 | 504.915 | 505.412 | 505.943 | 506.531 | 507.197 | 507.932 | 508.737 | 509.604 | - | - | - |
| Step 118 | Lift T3B-11: Cast Remaining Ballast Lifts at Pier 2 | 504.042 | 504.498 | 504.994 | 505.521 | 506.081 | 506.698 | 507.395 | 508.160 | 508.996 | 509.894 | - | - | - |
| Step 119 | Lift T3M-11: Position New Grillage Segment | 504.042 | 504.498 | 504.994 | 505.521 | 506.081 | 506.698 | 507.395 | 508.160 | 508.996 | 509.894 | 510.806 | - | - |
| Step 120 | Lift T3M-11: Stress Diagonal Bracing | 504.018 | 504.449 | 504.922 | 505.425 | 505.957 | 506.531 | 507.157 | 507.811 | 508.485 | 509.167 | 509.792 | - | - |
| Step 121 | Lift T3M-11: Place First 6 Precast Panels | 503.984 | 504.381 | 504.821 | 505.290 | 505.781 | 506.293 | 506.820 | 507.324 | 507.783 | 508.183 | 508.456 | - | - |
| Step 122 | Lift T3M-11: Install & Stress Partial Stays (1A) | 503.983 | 504.378 | 504.815 | 505.281 | 505.769 | 506.283 | 506.818 | 507.342 | 507.835 | 508.285 | 508.639 | - | - |
| Step 123 | Lift T3M-11: Place Remlaining Precast Panels | 503.943 | 504.296 | 504.692 | 505.118 | 505.557 | 505.998 | 506.419 | 506.769 | 507.016 | 507.146 | 507.119 | - | - |
| Step 124 | Lift T3B-12: Place Precast Panels | 503.955 | 504.321 | 504.731 | 505.171 | 505.624 | 506.080 | 506.516 | 506.881 | 507.142 | 507.288 | 507.276 | - | - |
| Step 125 | Lift T3M-11: Install & Stress Full Stays (1B) | 503.951 | 504.311 | 504.712 | 505.141 | 505.588 | 506.048 | 506.512 | 506.941 | 507.313 | 507.625 | 507.881 | - | - |
| Step 126 | Lift T3M-11: Re-Stress Full Stays (1C) | 503.950 | 504.310 | 504.710 | 505.138 | 505.583 | 506.046 | 506.519 | 506.964 | 507.364 | 507.718 | 508.089 | - | - |
| Step 127 | Lift T3M-11: Cast CIP Stitch | 503.932 | 504.271 | 504.651 | 505.058 | 505.479 | 505.910 | 506.340 | 506.727 | 507.053 | 507.320 | 507.561 | - | - |
| Step 128 | Lift T3M-11: Re-Stress Stays (2) | 503.932 | 504.267 | 504.636 | 505.029 | 505.446 | 505.906 | 506.429 | 507.004 | 507.639 | 508.343 | 509.108 | - | - |
| Step 129 | Lift T3B-12: Cast CIP Stitch | 503.937 | 504.279 | 504.654 | 505.053 | 505.477 | 505.944 | 506.473 | 507.055 | 507.697 | 508.408 | 509.181 | - | - |
| Step 130 | Lift T3B-12: Install & Stress Stays (1A) | 503.967 | 504.340 | 504.749 | 505.183 | 505.642 | 506.146 | 506.713 | 507.333 | 508.015 | 508.764 | 509.577 | - | - |
| Step 131 | Lift T3M-12: Position New Grillage Segment | 503.967 | 504.340 | 504.749 | 505.183 | 505.642 | 506.146 | 506.713 | 507.333 | 508.015 | 508.764 | 509.577 | 510.401 | - |
| Step 132 | Lift T3M-12: Stress Diagonal Bracing | 503.947 | 504.300 | 504.689 | 505.106 | 505.547 | 506.023 | 506.545 | 507.090 | 507.651 | 508.226 | 508.805 | 509.325 | - |
| Step 133 | Lift T3M-12: Place First 6 Precast Panels | 503.920 | 504.245 | 504.609 | 505.001 | 505.416 | 505.855 | 506.315 | 506.759 | 507.165 | 507.518 | 507.807 | 507.968 | - |
| Step 134 | Lift T3M-12: Install & Stress Partial Stays (1A) | 503.919 | 504.243 | 504.604 | 504.993 | 505.405 | 505.843 | 506.306 | 506.760 | 507.188 | 507.578 | 507.923 | 508.170 | - |
| Step 135 | Lift T3M-12: Place Remlaining Precast Panels | 503.887 | 504.177 | 504.506 | 504.866 | 505.245 | 505.638 | 506.029 | 506.368 | 506.617 | 506.753 | 506.769 | 506.629 | - |
| Step 136 | Lift T3M-12: Install & Stress Full Stays (1B) | 503.883 | 504.169 | 504.491 | 504.841 | 505.210 | 505.599 | 506.000 | 506.373 | 506.694 | 506.949 | 507.141 | 507.277 | - |
| Step 137 | Lift T3M-12: Re-Stress Full Stays (1C) | 503.883 | 504.168 | 504.490 | 504.838 | 505.206 | 505.595 | 506.000 | 506.381 | 506.718 | 507.000 | 507.229 | 507.423 | - |
| Step 138 | Lift T3M-12: Cast CIP Stitch | 503.868 | 504.138 | 504.444 | 504.776 | 505.127 | 505.495 | 505.869 | 506.209 | 506.488 | 506.695 | 506.837 | 506.950 | - |
| Step 139 | Lift T3M-12: Re-Stress Stays (2) | 503.870 | 504.138 | 504.436 | 504.756 | 505.093 | 505.463 | 505.877 | 506.322 | 506.804 | 507.333 | 507.920 | 508.561 | - |
| Step 140 | Lift T3B-13: Install & Stress Stays (1) | 503.934 | 504.272 | 504.643 | 505.038 | 505.453 | 505.903 | 506.399 | 506.929 | 507.497 | 508.113 | 508.789 | 509.519 | - |
| Step 141 | Lift T3B-12: Re-Stress Stays (1B) | 503.956 | 504.317 | 504.713 | 505.133 | 505.574 | 506.051 | 506.575 | 507.133 | 507.729 | 508.376 | 509.080 | 509.840 | - |
| Step 142 | Lift T3B-13: Stress Backspan PT | 503.956 | 504.318 | 504.714 | 505.135 | 505.577 | 506.054 | 506.579 | 507.137 | 507.734 | 508.381 | 509.086 | 509.846 | - |
| Step 143 | Lift T3M-13: Position New Grillage Segment | 503.956 | 504.318 | 504.714 | 505.135 | 505.577 | 506.054 | 506.579 | 507.137 | 507.734 | 508.381 | 509.086 | 509.846 | 510.614 |
| Step 144 | Lift T3M-13: Stress Diagonal Bracing | 503.941 | 504.286 | 504.667 | 505.075 | 505.505 | 505.968 | 506.468 | 506.981 | 507.499 | 508.020 | 508.544 | 509.066 | 509.529 |
| Step 145 | Lift T3M-13: Place First 6 Precast Panels | 503.919 | 504.243 | 504.604 | 504.994 | 505.408 | 505.849 | 506.314 | 506.765 | 507.179 | 507.538 | 507.832 | 508.058 | 508.159 |
| Step 146 | Lift T3M-13: Install & Stress Partial Stays (1A) | 503.919 | 504.242 | 504.601 | 504.990 | 505.401 | 505.841 | 506.305 | 506.760 | 507.182 | 507.556 | 507.875 | 508.137 | 508.292 |
| Step 147 | Lift T3M-13: Place Remlaining Precast Panels | 503.893 | 504.190 | 504.524 | 504.891 | 505.282 | 505.696 | 506.119 | 506.500 | 506.797 | 506.975 | 507.014 | 506.917 | 506.645 |
| Step 148 | Lift T3M-13: Cast CIP Stitch | 503.882 | 504.166 | 504.489 | 504.845 | 505.226 | 505.627 | 506.031 | 506.379 | 506.623 | 506.721 | 506.651 | 506.419 | 505.996 |
| Step 149 | Lift T3M-13: Install & Stress Full Stays (1B) | 503.879 | 504.159 | 504.475 | 504.819 | 505.186 | 505.575 | 505.977 | 506.349 | 506.659 | 506.884 | 507.015 | 507.056 | 506.955 |
| Step 150 | Lift T3M-13: Re-Stress Stays (2) | 503.881 | 504.161 | 504.471 | 504.804 | 505.155 | 505.532 | 505.942 | 506.366 | 506.802 | 507.258 | 507.745 | 508.264 | 508.720 |

# GEOMETRY CONTROL

Parameters that go into the calculations:

- Design profile
- Design Cambers
- As-built geometry
- Long-term movements (creep, shrinkage)
- Erection sequence
- Temporary loads
- Ambient temperatures



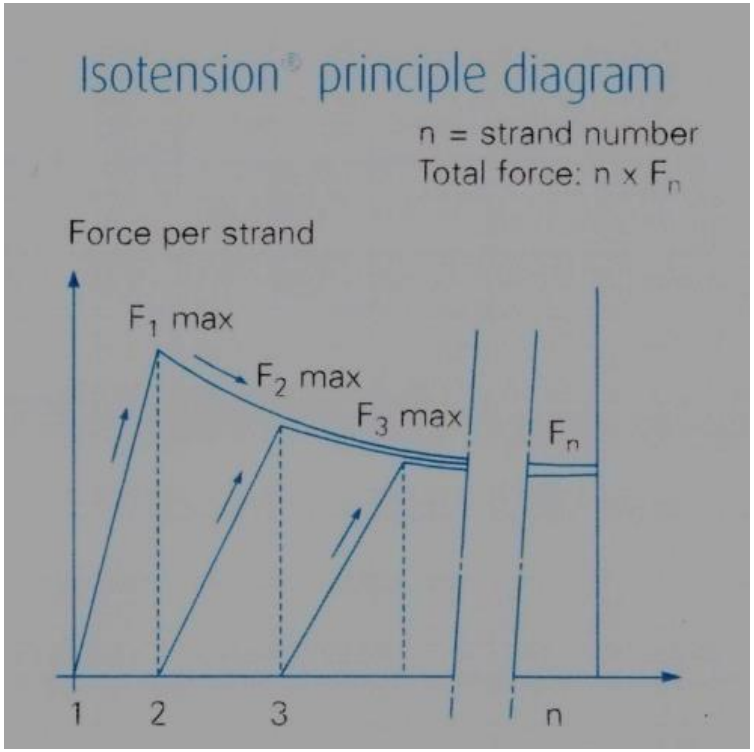
# GEOMETRY CONTROL

You had one job.

# CABLE INSTALLATION

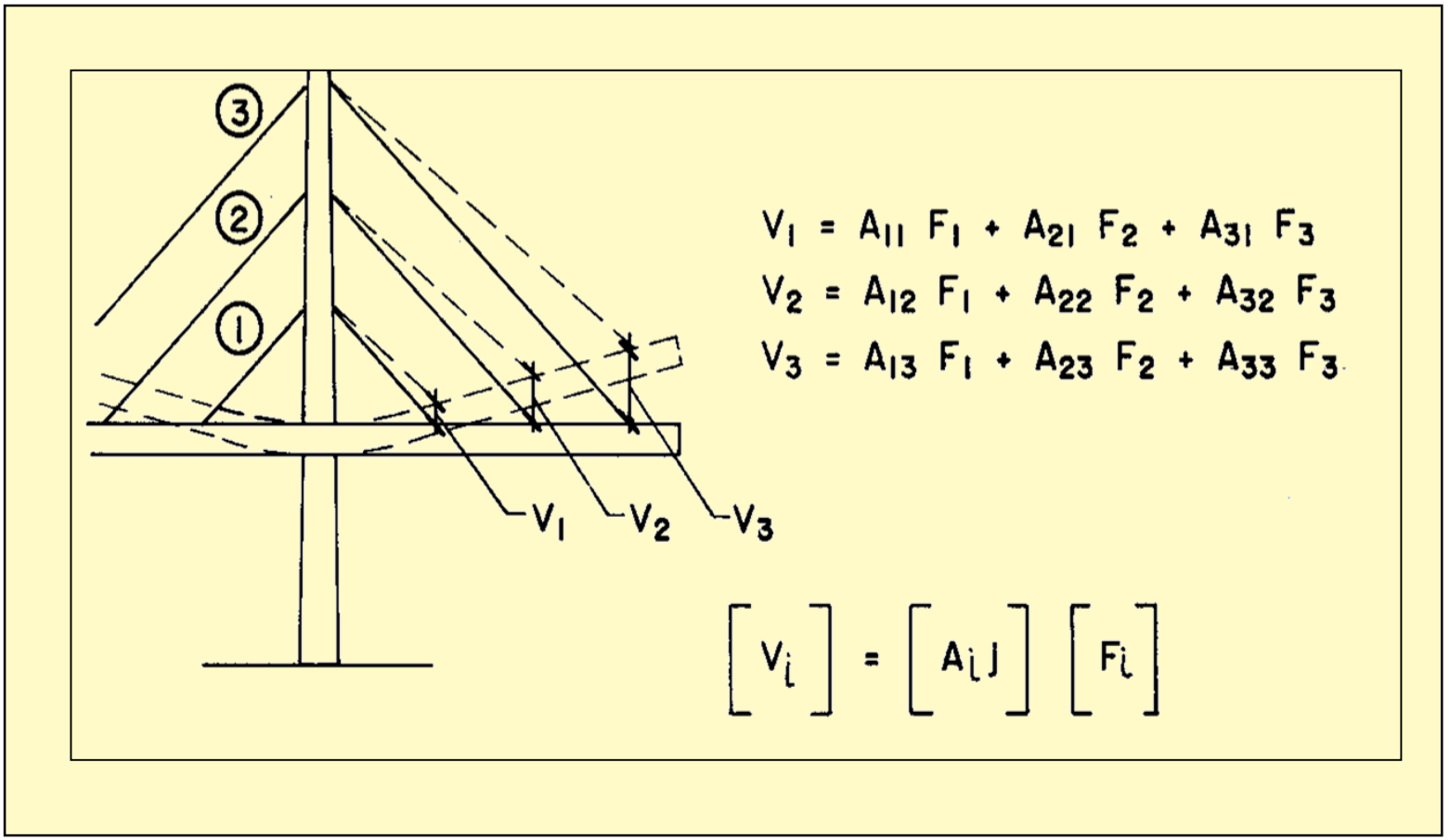

Stressing equipment and construction engineering are tied together.

# CABLE INSTALLATION


Monostrand stressing adds complexity

# CABLE INSTALLATION



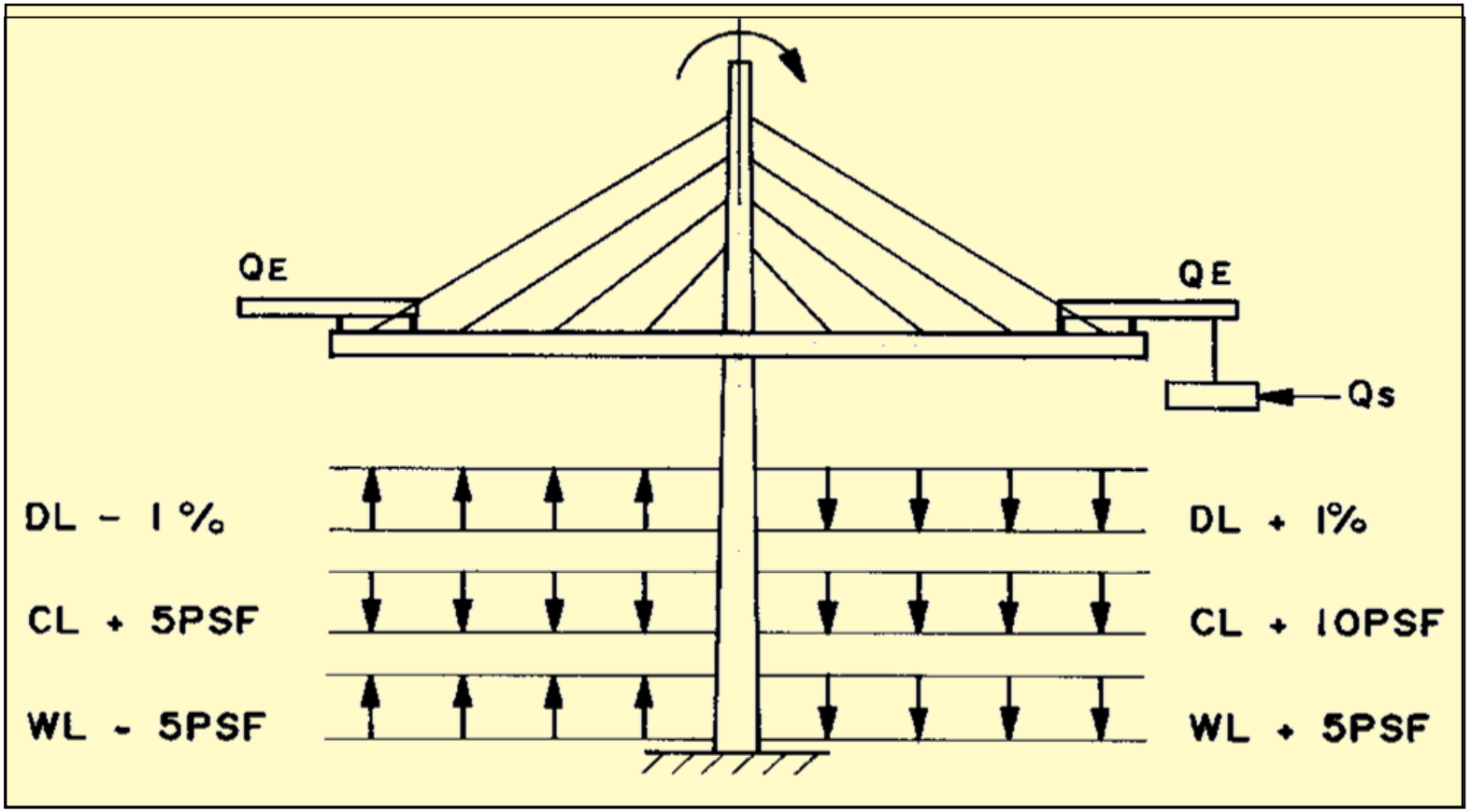

Each stay affects the others.

# STRUCTURAL CHECKS

Structural checks can be thought of as “big picture” items – those affecting the overall strength and stability, and “small picture” items affecting local member capacity.

The challenge with both of these are that the system is constantly changing.

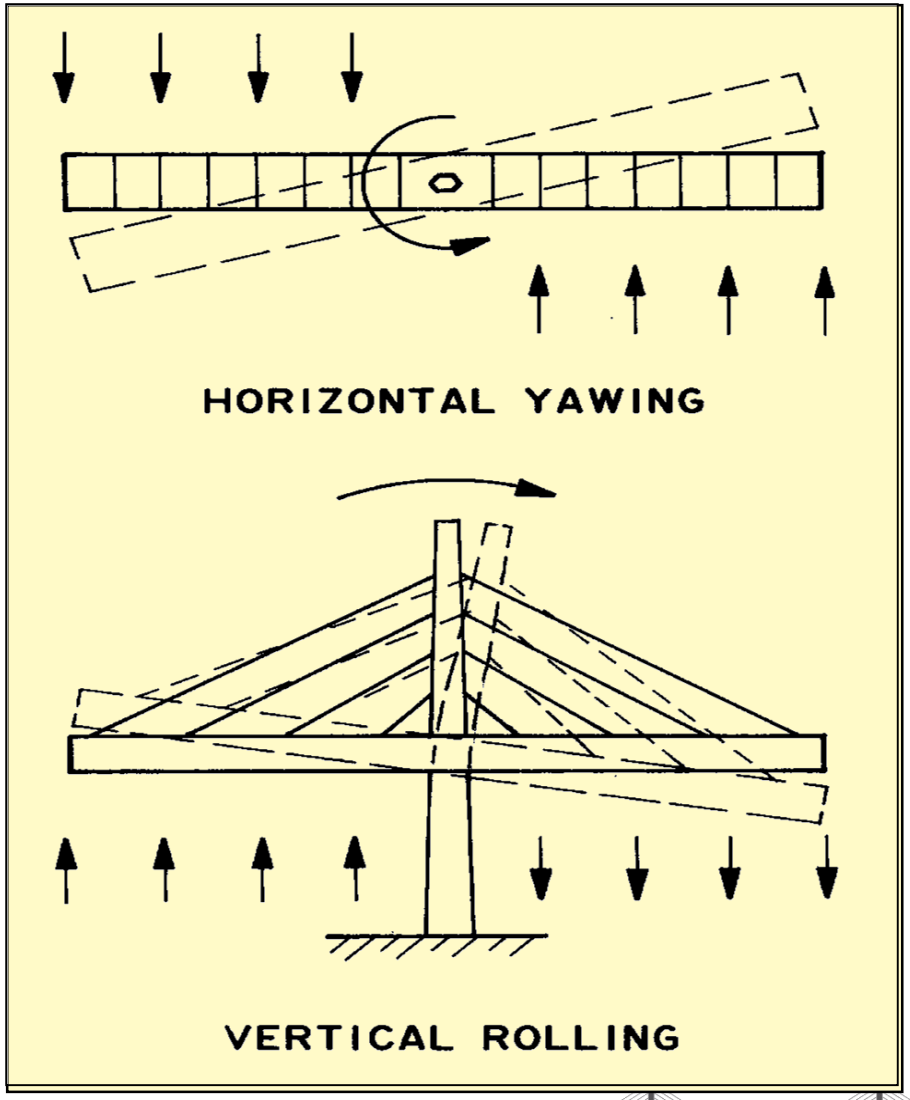
# STRUCTURAL CHECKS




Overturning effects are significant.

# STRUCTURAL CHECKS

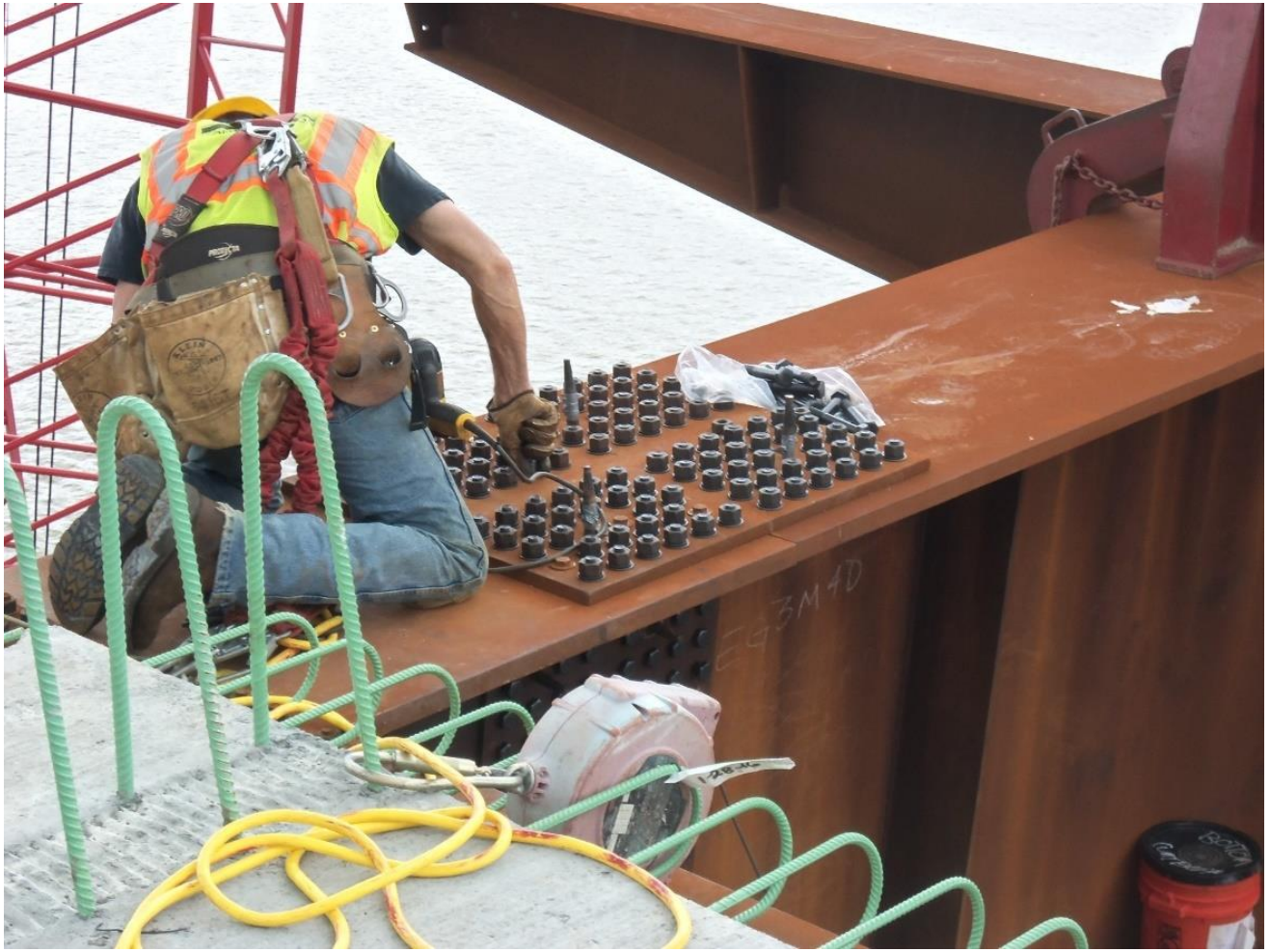
Wind induces overturning and twisting.



# STRUCTURAL CHECKS

Code values underestimate wind.

# STRUCTURAL CHECKS



Small picture considerations

# STRUCTURAL CHECKS

# STRUCTURAL CHECKS

# STRUCTURAL CHECKS

# STRUCTURAL CHECKS

Engineer's Question:

"How much does it weigh, and where are you putting it?"

Contractor's Answer:

"What's the biggest load that I can put in the worst possible place?"

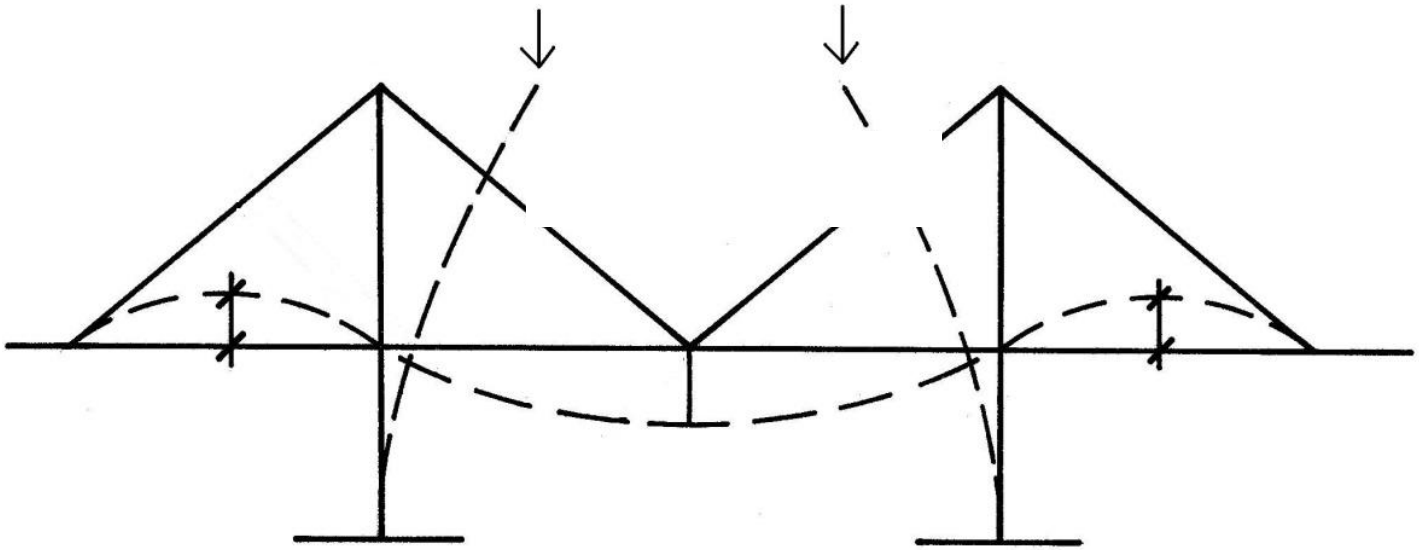
# TRADEOFFS

There can be a relationship between material costs and construction speed and complexity.

Which one is preferable often depends on where you are in the process.

# TRADEOFFS

# TRADEOFFS



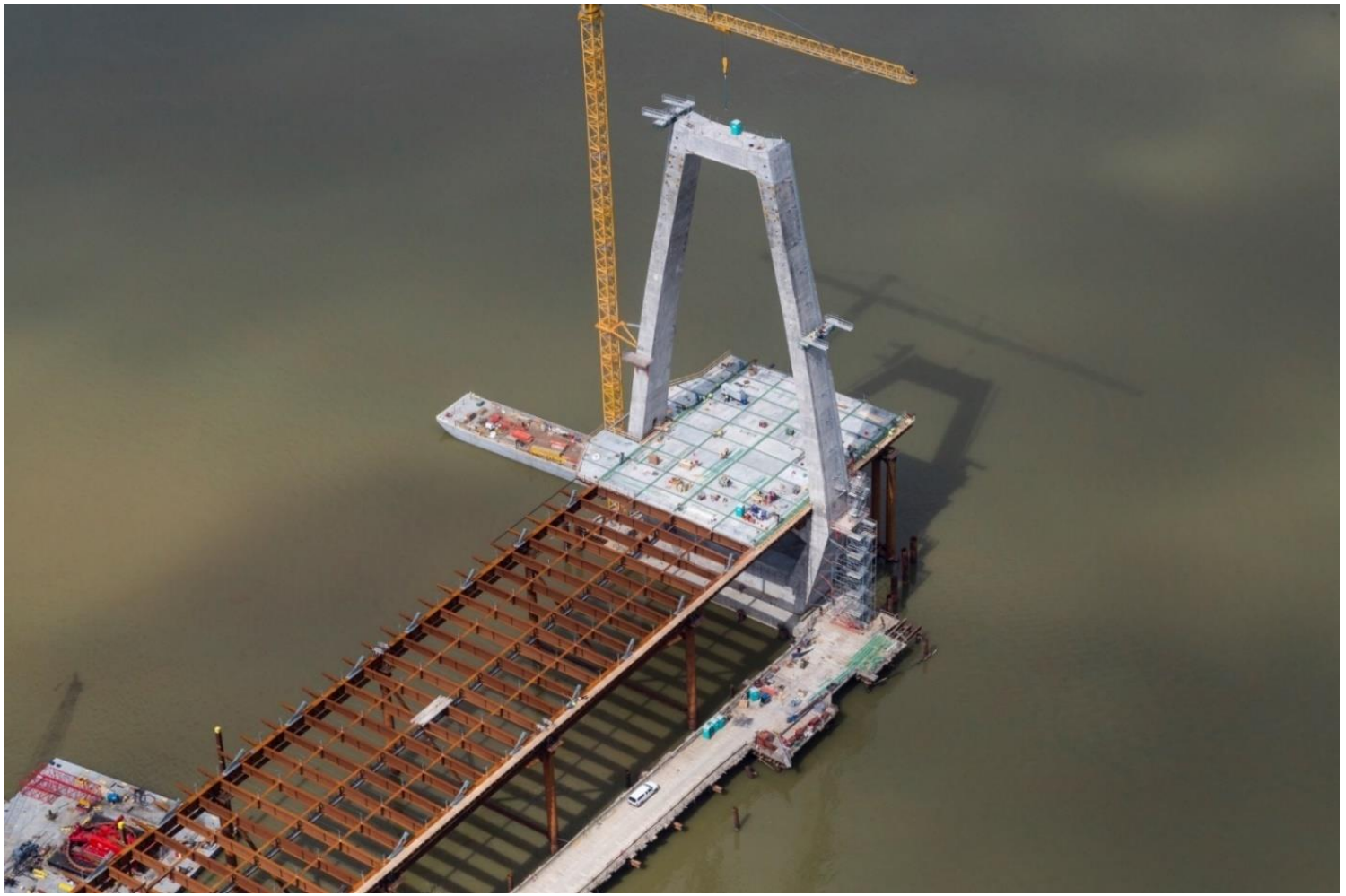
The choice is between cambering the girders up and paying for extra steel, or restressing the stays after placement.

In general, the WVC team opted for complexity over materials.

# OUR SOLUTIONS

Backspan Steel

# OUR SOLUTIONS



Pier Table on shoring.

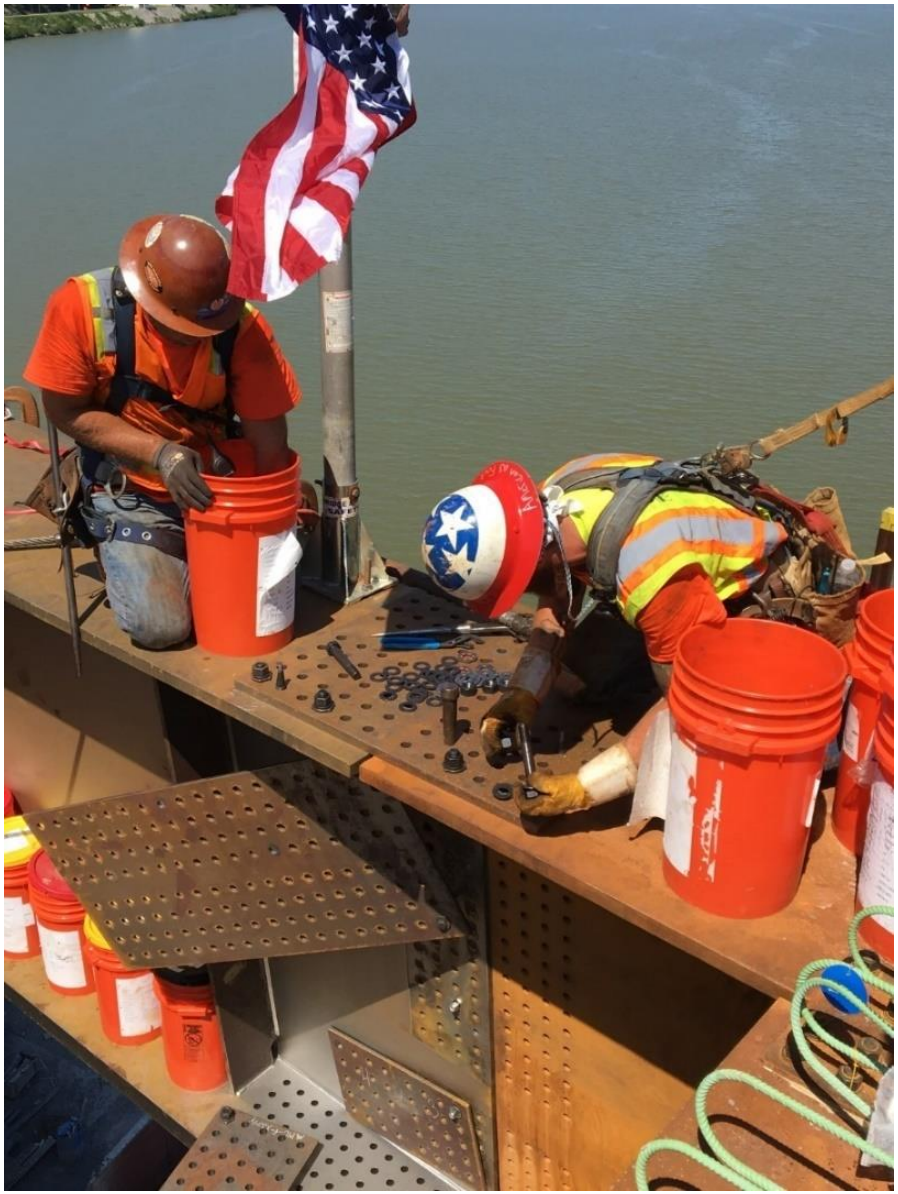
# OUR SOLUTIONS

Backspan first

# OUR SOLUTIONS


Main span cycle part 1

# OUR SOLUTIONS



Field bolting time is minimized.

# OUR SOLUTIONS


Main span cycle part 2

# OUR SOLUTIONS

Precast panel placement

# OUR SOLUTIONS


Main span cycle part 3

# OUR SOLUTIONS

Installed from the deck, stressed in the pylon

# OUR SOLUTIONS


Main span cycle part 4

# OUR SOLUTIONS

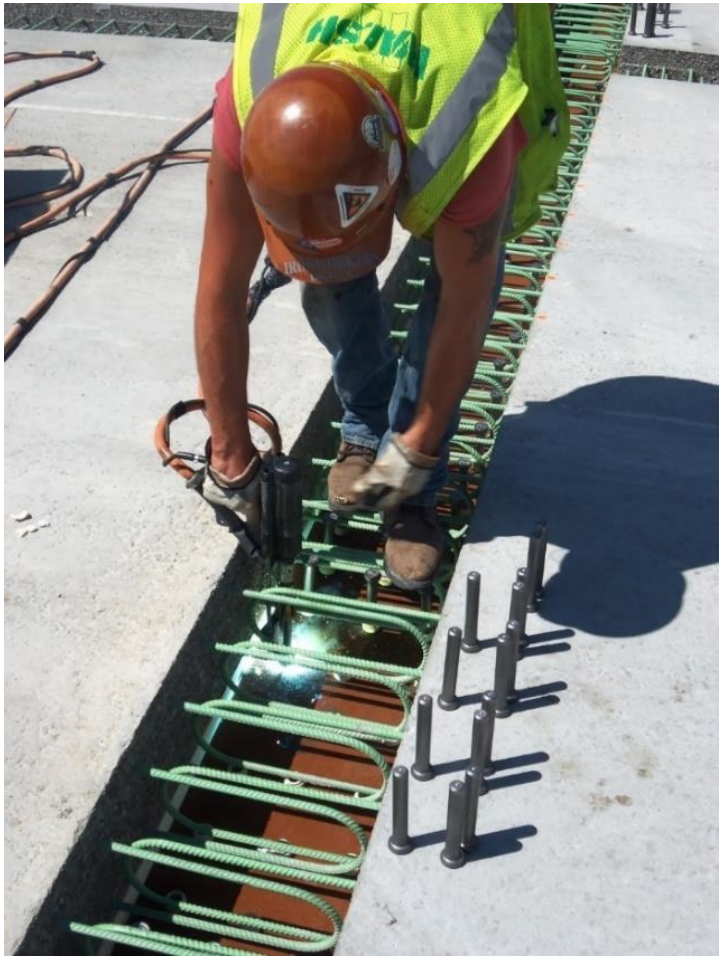
# OUR SOLUTIONS

Re-stress to target geometry

# OUR SOLUTIONS


Main span cycle part 5

# OUR SOLUTIONS



Studs are placed and stitches cast.

# OUR SOLUTIONS

Yet more stressing

# OUR SOLUTIONS

Overlapping cycles